The Influence of Location on the Structure and Functioning of Private Land Conservation Networks in the Western Cape Province of South Africa

By

Julia Baum

Submitted in fulfilment of the requirements for

the degree of

PHILOSOPHIAE DOCTOR

In the Faculty of Science,

Department of Biological Sciences,

at University of Cape Town

12th February 2016

Advisor: Prof G. S. Cumming

Acknowledgements

I would like to take this opportunity to acknowledge people who contributed to the successful completion of this work. First, sincere thanks are made to Prof Graeme S. Cumming, my advisor, who supported and encouraged me steadfastly and whom I thank for sharing his knowledge and expertise. Second, my sincere gratitude goes to all study participants, owners and managers of Private Land Conservation Areas across the Western Cape Province, who provided the basis and many more invaluable contributions to my research. I experienced heartily encounters and established valuable relationships.

My research would not have been possible without the logistical and financial support from the Percy FitzPatrick Institute, the University of Cape Town, the National Research Foundation, and the James S. McDonnell Foundation. I also want to thank all other collaborators and in particular my colleagues for fruitful discussion, help with analyses, and last but not least joyful times.

Most grateful am I towards my friends and family, mainly my brother and my parents. Thank you for supporting me, encouraging me, loving me, motivating me... to name but a few aspects of what I experienced from you accompanying me along this way.

Declaration

I, *Julia Baum (student number BMXJUL001)*, hereby declare that the dissertation for the degree of PHILOSOPHIAE DOCTOR is my own work and that it has not previously been submitted for assessment or completion of any postgraduate qualification to another university or for another qualification.

Julia Baum

Table of Contents

Abstract

Protected areas are an important tool for biodiversity conservation. Statutory protected areas are, however, perceived to currently be insufficient in extent and functioning for achieving conservation goals. Conservation action on privately owned land plays an increasingly vital role in expanding the global conservation estate. Private Land Conservation Areas (PLCAs) exist with internal properties and external contexts and do not occur isolated in space and time. They can thus best be described as linked social-ecological systems. Little comprehensive work has yet been done concerning the structure and functioning of PLCAs. However, an understanding of their emergence, long-term persistence and contribution to conservation is highly relevant. How can PLCAs maintain their identity against disturbances in order to be resilient into the future? Spatial patterns and relationships determine the answer to this question. Geographical location influences the private conservation estate through different drivers, namely biophysical conditions, network connections and membership, as well as socio-economic conditions. I thus used a comparative, spatially explicit and holistic approach to better understand spatial resilience of PLCAs in the Western Cape Province of South Africa as case study region. The approach was based on assessing representative measures for four elements of system identity (being components, relationships, sources of continuity, and sources of innovation). I expected that geographical location and spatial variation in social-ecological factors strongly influence PLCA types, socio-economic interaction networks among protected areas and other stakeholders, contribution to conservation by PLCAs and their ecotourism performance. Information and data for this research were obtained from personal interviews conducted with owners and managers of 70 PLCAs across the province. Additional data were derived via conservation authorities and online tools. My findings show that the identity and resilience of PLCAs are strongly dominated by the influence of spatial location and heterogeneity in factors such as ecological features or socio-economic context. I was able to verify existing PLCA types, namely game and habitat reserves, which strongly depended on the biophysical context. Visitation rates were influenced by location which determined the adopted corporate model of PLCAs. Clear neighbourhood effects emerged in socio-economic interaction networks, which further highlighted great potential to enhance collaboration across scales. PLCAs provided a substantial contribution to conservation targets in terms of importance (covering critical biodiversity areas) and urgency (protecting ecosystems of threatened status). My findings will be valuable to highlight opportunities for more effective conservation in the study region, and to advance insights into the spatial resilience of social-ecological systems.

Keywords: Private Land Conservation, Social-Ecological Systems, Spatial Resilience, Biodiversity Conservation, Networks, Protected Areas, Sustainability, Ecotourism, System Identity

Chapter 1: Introduction

The rate at which species are globally going is a cause for major concern. One of the main responses of the conservation community has been to try to increase the extent of areas 'set aside for nature'. The Convention on Biological Diversity's Aichi 11 target, for example, has been set at 17% for terrestrial and 10% for marine environments by 2020 (CBD Secretariat 2015), and there are currently moves to increase these targets to a global 30% for 'no take' reserves and 50% overall (IUCN World Parks Congress 2014).

Effective conservation is becoming increasingly important for securing a sustainable future on Earth. There are many different approaches to conservation but implementing protected areas (PAs) is a crucial tool. The need for conserving more land is very clear since habitat loss and fragmentation are widely recognized as the dominant causes of species loss (Pimm & Raven 2000). PAs, however, not only achieve biodiversity conservation (i.e. protection of species and habitats) but can be perceived as institutions which link social and ecological systems by providing both tangible and intangible benefits to society (i.e., ecosystem services such as generation of economic revenue or recreation) (Infield 2001; Sundaresan & Riginos 2010; Kettunen & ten Brink 2013; Cumming et al. 2015b). Thus, PAs are mostly maintained and managed by governments or other institutional actors with the purposes of protecting biodiversity against disturbances such as pollution or overexploitation, the preservation of habitats and the safeguarding of ecosystem services provision (Margules & Pressey 2000).

Less clear is how global expansion of conservation estates can be achieved in the context of economic growth and development demanded by growing human populations. As urban centres expand, resource demands are increasing and landscapes become highly populated. Fewer opportunities become available to increase or extend governmentally- or community-owned PAs. Within recent decades, conservation action on private land has started to complement statutory PAs in many countries and to make a significant contribution to an overall expansion of the conservation estate, but their potential for biodiversity conservation is often overlooked (Lindsey et al. 2014).

Contemporary PAs under governmental management have been in use for more than a century (Yellowstone National Park, the first national park in the world, was created in the United States of America in 1872), however, much older types of conservation and protected areas exist globally, such as sacred forests. PA functioning and long-term dynamics often remain poorly understood, for example in conserving species or providing ecosystem services. This lack of knowledge is particularly relevant to Private Land Conservation Areas (PLCAs) which offer a potential supplementary solution to statutory PAs. These are seen as ‘islands of protection’ and have, since the 1970's, been regarded as not providing enough space for effective long-term protection of ecological processes and patterns (Kreuter et al. 2010). Statutory PAs often occur in areas of economically marginal land; at high altitudes; on steep slopes; or in less threatened habitats (Gallo et al. 2009; Joppa & Pfaff 2009). Statutory PAs are often also biased towards certain geologic substrates, protect few ecosystem types effectively, and may leave some habitats and threatened species under- or unrepresented (e.g. Barnard et al. 1998; Rouget et al. 2003; Brooks et al. 2004; De Klerk et al. 2004; Gallo et al. 2009; Joppa & Pfaff 2009). This low performance is based on the fact that many statutory PAs were established for reasons different to and before the implementation of contemporary biodiversity measures and conservation targets, for example based on recreational value. Also, conservation was formerly often considered a worthless land use. Some authors argue that statutory PAs formerly have been implemented on "empty lands" (Runte 1997). Thus, their effectiveness and role have been questioned widely (Pouliquen-Young 1997; Runte 1997). Many areas of great conservation value are placed in high production landscapes (Gallo et al. 2009), of which large parts are privately owned. Private Land Conservation (PLC) is thus of increasing importance for maintaining and expanding the global conservation estate (Barnard et al. 1998; Fitzsimons & Wescott 2001; Child et al. 2013). PLCAs may not, however, guarantee long-term, sound management or coordinated decisions (Kreuter et al. 2010). They may also have a tenuous legal status, which is a concern for the long-term protection of biodiversity (Langholz & Lassoie 2001; Langholz & Krug 2004; Pasquini et al. 2011). However, similar concerns arise for statutory PAs related to their long-term effectiveness and persistence. Many PAs are subject to downgrading, downsizing or degazettement and legal status does not always prevent such measures (Mascia & Pailler 2010).

Biodiversity conservation and ecosystem management and valuation are influenced by normative values, societal concepts and societal needs and problems (such as ecological sustainability, economic efficiency, social equity) which lead to choices of targets and procedures (Wilson & Howarth 2002; Berkes & Turner 2006; Sutherland et al. 2009). Conservation can no longer focus on ecological patterns and processes but has to strengthen holistic approaches which include socio-economic aspects in conservation strategies. Therefore, conservation is in need of research insights and results which can explain the relatedness and interaction of social and ecological components and their functioning as an entire system. My study seeks to assess and better understand the private conservation estate and its contribution to conservation by addressing questions of spatial resilience.

1.1 Biodiversity and Conservation

In the UN's Convention on Biological Diversity from 1992, biological diversity is defined as "the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems" (CBD Secretariat 2015a). Assessing biodiversity is a challenge and depends on appropriate indicators for monitoring. A hierarchical approach was suggested by Noss (1990) in which the three elements of biodiversity - composition, structure and function - should be considered at four levels of organization, namely regional landscapes; community-ecosystem; population-species; and genetic. Biodiversity (e.g., genetic species diversity, redundancy of functional species, heterogeneity of habitats) is essential for maintaining productivity in ecosystems, and ecosystem functioning has been found to be sensitive to changes in biodiversity (Tilman & Downing 1994).

Assessing and long-term monitoring of biodiversity enhances our understanding of the functioning, productivity and resilience of ecosystems. Such an understanding is important, because ecosystems provide tangible and intangible benefits to society, for example economic or recreational values. Human well-being is directly dependent on the provision of these benefits (Millennium Ecosystem Assessment 2005). A widely applied approach for understanding and quantifying these benefits is the framework of Ecosystem Services (Ehrlich & Mooney 1983; Daily 1997; Millennium Ecosystem Assessment 2005). It allows for a generalized categorization of the provided benefits which fosters an understanding of supply and demand, their evaluation, and an implementation of strategies for maintaining their provision. The concept of ecosystem services is suitable for implementation in conservation. For example, considering the establishment or maintenance of a PA may largely depend on which benefits the area provides to society, who the beneficiaries are and whether conflict around trade-offs can be solved.

However, the persistence of biodiversity and ongoing provision of ecosystem services is threatened. Growing human populations and their activities have altered landscapes globally, putting ecosystems under pressure (Steffen et al. 2004). The rate at which biological diversity is lost was defined as one of nine planetary boundaries which determine a safe operating space for humanity (Rockström et al. 2009). The authors estimated that the boundary of biodiversity loss has already been transgressed, which may lead to ecosystems crossing other thresholds that possibly trigger non-linear, abrupt environmental change.

There is therefore an increasing need to further conserve biodiversity and to make management more effective. Current approaches to evaluate the effectiveness of PAs often focus on the provided coverage and broad-scale outcomes such as species populations (Geldmann et al. 2013). Increasingly, assessments of PA management effectiveness are implemented for one or more of four basic purposes: improving protected area management, increasing accountability, communicating with the public, and assisting in prioritization of resourcing. On a fourth level, assessments consist of detailed monitoring and reporting on the condition and trend of specific PA values such as animal populations, forest condition, cultural values and socioeconomic impacts (Leverington et al. 2010). PAs play a vital role in conservation by safeguarding natural areas which would otherwise have been subject to land-use change. Areas of conservation significance face, since decades, increased pressure and impact through anthropogenic factors (Folke et al. 1996). The ability of existing PAs to adequately conserve biodiversity is questionable since they leave many species and ecosystems underrepresented or unrepresented (Fjeldså et al. 2004). One potential solution for improving the representation of protected biodiversity is expanding the global conservation estate (Chape et al. 2005). Expanding PAs involves securing more land for conservation. Identification of such land is mostly based on ecological indicators for monitoring species diversity, their habitats and distributional patterns and processes. Distribution and migration of species, however, is embedded in cultural landscapes. Through the lens of human well-being, it should be considered to further identify areas for PA expansion based on the provision of ecosystem services. Such an approach would allow for both the protection of the provided benefits to society as well as the underlying biophysical structures and processes.

The human dimension thus cannot be set aside in conservation research (e.g. Whitehead et al. 2014). In fact, it is a main driver of conservation determining where and how action is undertaken and which patterns arise (Mascia et al. 2003). Therefore, Knight et al. (2010) call for an investigation of conservation opportunity rather than solely conservation priority. Spatial prioritization is frequently based solely on ecological data to identify areas of high conservation importance. But awareness is growing that social and economic data are also important for prioritization, for example the accessibility of nature reserves to society in order to benefit from ecosystem services and recreation provided (Onal & Briers 2002) or the availability of land for conservation through acquisition (Knight et al. 2011). Including these different data allows for implementing specific actions effectively and the research-implementation gap to be bridged.

In general, questions about space and scale are main research topics within the field of conservation biogeography, which was defined by Whittaker et al. (2005) as 'the application of biogeographical principles, theories, and analyses, being those concerned with the distributional dynamics of taxa individually and collectively, to problems concerning the conservation of biodiversity'. Still uncommon in this field, however, are syntheses that combine social and ecological system perspectives (Cumming et al. 2010). Such syntheses are, however, of importance in order to suitably manage patterns and processes in ecosystems (Cumming et al. 2010).

1.2 Protected Areas as Social-ecological Systems

Historically, PAs have served to secure natural areas while excluding people, ('fortress conservation') (Kepe et al. 2004; Hutton et al. 2005). Since the 1990's, fortress conservation has been widely complemented by new approaches, such as community conservation initiatives (e.g. Hutton et al. 2005; Naughton-Treves et al. 2005). Many institutions, stakeholders and scientists now perceive both the system in which conservation action takes place and individual PAs as fundamentally social-ecological in nature (González et al. 2008; Knoot et al. 2010; Cumming et al. 2013; Guerrero et al. 2013).
PAs include anthropogenic components. They are driven by human action and are subject to social definition, construction and management and are responsive to social pressures (Mascia & Pailler 2010). They provide cultural services, such as ecotourism (e.g. Lindsey et al. 2007), as well as other benefits of social importance, e.g. employment opportunities (e.g. Sims-Castley et al. 2005). PAs simultaneously incorporate ecological features. They protect terrestrial and aquatic habitats as well as many endangered species and provide space for ecological patterns and processes representing all levels of biodiversity (Margules & Pressey 2000; Lindsey et al. 2005). PAs provide ecosystem services and serve as patches for migrating species (e.g. Calhoun et al. 2014).

In light of these characteristics it is apparent that PAs are social-ecological systems (SESs). This may seem obvious to scholars of the resilience school, however, concepts of complex systems and systems thinking are not necessarily mainstream in wider society. Therefore, broader fostering of such knowledge is important as SES components cannot easily be parsed from each other (Walker et al. 2006). They are interdependent and interact non-linearly and across scales in time and space (Liu et al. 2007). Change in properties in one part of the system may trigger unexpected changes in other parts of the system via complex feedback loops. In many cases, such changes happen with legacy effects and time lags (Liu et al. 2007) and may be irreversible (Anderies et al. 2013). Furthermore, system structure and dynamics are scale-sensitive (Scholes et al. 2013). Properties and patterns on higher levels of organisation emerge from interactions and changes at lower levels; vice versa conditions and dynamics on higher levels can in turn influence the system at lower levels (Levin 1998; Olsson et al. 2004). The intensity of effects is determined by the system panarchy, i.e. the degree by which a certain hierarchical level is influenced by other levels (Walker et al. 2004). SESs are dynamic, non-equilibrium systems that may be subject to regime shifts (Levin et al. 1998; Kinzig et al. 2006; Biggs et al. 2012). Several potential stable states, or regimes, may occur (Levin 1998), and a system may be altered without immediately losing its overall identity (Collier 2010; Folke et al. 2010; Maciejewski et al. 2015). SESs hold the capacity of reactive or proactive adaptive behaviour by means of self-organisation, learning and reasoning (e.g. Folke et al. 2004; Norberg & Cumming 2008; Cumming et al. 2013b). These properties at interplay with system components and drivers provide for a comprehensive potential for adaptive capacity and for diverse opportunities of mechanisms to build and maintain resilience (see section 1.3).

Today, more than ever, learning how to adapt to and manage SESs in the face of uncertainty and potential regime shifts is essential (Olsson et al. 2004). Questions arise about a system's capacity to persist or recover from change, which is also referred to as system resilience. Two main notions of resilience occur in the literature. On the one hand resilience can be referred to as 'engineering resilience' (Holling 1973; Pimm 1991) where the main measure is "the time required for a system to return to an equilibrium or steady-state following a perturbation" (Gunderson 2000). The definition is based on an implicit assumption of a global equilibrium or stability. On the other hand resilience can be understood as 'ecological resilience' (Holling 1973; Walker 1981) where the main measure is "the magnitude of disturbance that can be absorbed before the system redefines its structure by changing the variables and processes that control behaviour" (Gunderson 2000). This understanding of resilience is based on the assumption that several stability domains exist and that perturbations may facilitate a system to transition from one to another stable state.

Both resilience definitions stem from and focus on a strongly ecological background. However, considering the provision of ecosystem services which is essential for human well-being, concurrent applications of resilience thinking also have to incorporate socio-economic dimensions and human-environmental interactions. The resilience of social systems depend on a range of institutional and other properties (such as governance, institutional design, property rights, communication, and trust) which influence sustainable development and sustainable management and utilisation of resources (Ostrom 1990; Levin et al. 1998). The Stockholm Resilience Centre defines resilience as "the capacity of a system, be it an individual, a forest, a city or an economy, to deal with change and continue to develop. It is about how humans and nature can use shocks and disturbances like a financial crisis or climate change to spur renewal and innovative thinking" (Stockholm Resilience Centre 2015). In SESs, loss of ecosystem resilience can lead to loss of valuable ecosystem services which can lead to effects or even shifts in socio-economic systems, for example knowledge systems. Vice versa, loss of resilience in socio-economic systems can lead to changes or shifts in ecosystems via for example altered resource utilisation (Cumming et al. 2014).

Cumming & Collier (2005), Cumming et al. (2005), and Cumming (2011) redefined resilience by integrating previous definitions of complex systems into a framework which is more useful for assessing SESs. A complex system encompasses: 1) components of which the system is comprised, which may be defined in varying degrees of detail; 2) relationships between these components; 3) the location and spatial scale at which the definition is applicable and the importance, or lack thereof, of spatial constancy; and 4) the temporal scale at which the definition is applicable and the author's perspective on the question of identity through time (Cumming & Collier 2005). Notably, incorporating spatial and temporal scales into an understanding of complex systems is important while addressing questions of resilience.

Following this definition, a SES can be characterized as resilient when it is able to maintain its identity in space and time against the influence of disturbances. Thus, the system identity to be maintained emerges as incorporating four elements: 1) system components, 2) relationships amongst components, 3) sources of continuity that contribute to the system’s persistence; and 4) sources of innovation that help components and relationships to adapt (Cumming et al. 2005).

As stated above, PAs are not isolated entities and are linked to their surrounding landscapes and subject to anthropogenic influences. Notably, both social and ecological system properties occur in space. Understanding spatial relations is of importance for suitably managing patterns and processes in ecosystems (Cumming et al. 2010). An assessment of PAs needs to identify and incorporate spatial factors and their influences on system identity in order to better understand PA resilience. This incorporation can be achieved by applying the framework of spatial resilience. Nyström & Folke (2001) defined spatial resilience as the dynamic capacity of a system to cope with disturbance and avoid thresholds at spatial scales larger than individual ecosystems and emphasized that the concept takes dynamic interactions and interdependencies between systems into account. A more recent and more expansive definition describes spatial resilience as "the ways in which spatial variation - including such things as spatial location, context, connectivity, and dispersal - influences (and is influenced by) the resilience of an SES or other complex system" (Cumming 2011).

1.3 Social-ecological System Identity and Desired Resilience

In order to assess the identity of PLCAs, the applied framework and especially its terminology needs to be further elucidated. Referring again to the work published by Cumming et al. (2005), I understand the identity of a complex adaptive system to comprise: 1) system components, 2) relationships amongst components, 3) sources of continuity and 4) sources of innovation.

System components, as first element of identity, are all direct characteristics, parts and actors which in combined form constitute the system as well as external factors or entities which affect the system - within its defined boundaries. For an individual PLCA, these can for example include the size of the property, the ecological features, the manager, visitors or economic conditions (e.g. Langholz 1996). On the level of an entire PA network, the components can for example represent all individual PAs involved, their coverage of specific habitats, the combined number of employees or the relevant legislation (Barnard et al. 1998; Lindsey et al. 2014).

System relationships represent links between individual system components. In a PLCA or PA network, these can be ecological processes such as species dynamics or disease regulation (De Vos et al. 2016a). Socio-economic relationships can be collaborations among managers, user perceptions, payments or law enforcements (e.g. Vance-Borland & Holley 2011).

Sources of continuity can be understood as the factors which constitute the adaptive capacity of a SES. They represent the basis on which capacity building is possible for a system to adapt to changes, deal with disturbances and to maintain its overall identity. Continuity factors include, among others, the social and cultural capital, diversity, redundancy, connectivity, natural capital, social and ecological memory of or in a system (e.g. Bengtsson et al. 2003; Turner et al. 2003; Pelling & High 2005; Barthel et al. 2010). In a PLCA, diversity could for example be represented by different income sources to ensure overall economic viability. In an entire PA system, diversity could for example be represented by several different corporate models of PAs, such as nationals parks, provincial nature reserves, conservancies, transfrontier areas or various types of PLCAs (e.g. Fitzsimons & Wescott 2008a; Cumming et al. 2015a).

Sources of innovation can be understood as the mechanisms for building and ensuring adaptive capacity of a SES. Such mechanisms allow a system to adapt to change, react to disturbances and maintain its identity. Adaptive capacity and thus system resilience with respect to a desired state can be created and enhanced in both social and ecological aspects as well as on different scales. In general, building desired resilience of SESs can be achieved via seven criteria: maintaining diversity and redundancy, managing connectivity, managing slow variables and feedbacks, fostering complex adaptive system thinking, encouraging learning, broadening participation, and promoting polycentric governance systems (Biggs et al. 2012). In relation to PAs and ecosystem stewardship, for example, creating stakeholder networks, establishing adaptive governance, building trust and vision or implementing bridging organizations which address issues across scales can help to strengthen the effectiveness of conservation (Folke et al. 2011; Westley et al. 2013).

In my research, I understand desired resilience as the state in which a system is able to adapt to change, deal with disturbances, or escape traps without losing its overall structure and function and without transitioning into another system state. Similar definitions were provided by Walker et al. (2004) and Folke et al. (2010) where resilience represents ‘‘the capacity of a system to absorb disturbance and reorganize while undergoing change, so as to still retain essentially the same function, structure, identity, and feedbacks’’.

For individual PLCAs or a PA network, the desired resilience would be to maintain major objectives (such as economic viability or protection of species) in order to achieve overall conservation targets. These objectives can be ensured by several mechanisms and may require adapting to changing internal or external factors. For example, a PLCA may change its corporate model to become more competitive and ensure economic viability, or change its focus in conservation management from single species to habitat protection. As long as the main outcome of contributing to biodiversity conservation is met and the main land use of biodiversity conservation or wildlife-based utilisation is not changed, the system remains in a desired state and is not losing its identity (Clements et al. 2016). This means, the reliability in service provision and the accountability in management actions of individual PLCAs as well as PA networks need to be strengthened.

1.4 Geographical Location and its Influences

Spatial location may affect PLCAs and their network through many different influences. These drivers can be summarized in three groups: biophysical conditions, network connections and membership, and socio-economic conditions.

Biophysical conditions refer to the ecological context in which a PLCA is established. Ecological gradients and different ecosystems can substantially influence management options and potential perturbation faced by a PLCA. In case a landowner is planning to invest in PLC and purchases a new property to manage as a reserve, the site may be chosen according to a certain type of habitat being present or the abundance of certain species. Preferences may arise due to rarity of habitats and species or due to suitability for ecotourism. When a landowner does not have an *a priori* choice, such as in an already established PLCA or when land use is being changed from traditional farming on an inherited property, biophysical conditions may determine the future development and management options based on carrying capacities or environmental problems, such as invasive plant species or disease outbreaks.

The second set of drivers includes network connections and membership. Networks, or clusters of PAs in close proximity, can influence PA resilience in three ways: by increasing the productivity of the PAS in the cluster, by driving innovation in the field, and by stimulating new PAs in the network. Close proximity may determine social bonds and interaction among PLCAs, as well as ecological connectivity. A landowner may choose his site for establishing a new reserve in close proximity to other PAs because he already experienced or hopes for positive collaborations or advantages for visitor access. Close proximity may allow for collective management in form of creating conservancies which may lead to removing fences between properties to enhance conservation outcomes or to creation of new tourism potential. From an ecological point of view, close proximity can enhance habitat connectivity, foster species migration and thus contribute to maintaining biodiversity. Contrarily close proximity and connectedness may cause competition relating to for example ecotourism and allow disturbances such as diseases to spread more easily within the network.

Socio-economic conditions include the surrounding local economy and society, infrastructure, political context, and destination choices made by tourists. Infrastructure may positively influence accessibility and logistics to a PA. Contrarily, urbanisation can pose a threat to protected areas by causing landscape fragmentation. The political context may represent legislative requirements for PA registration or land prices influencing investment. Cultural values, norms and attitudes towards conservation and resource management can either enhance the status of protected areas or create pressure through requested land use changes which are more desired, e.g. conflict arises when minerals get detected for mining in an area which is under protection. The surrounding local communities may, depending on their wealth, be involved in local trade networks for wildlife, legal hunting or illegal poaching activities. Tourists may place different relative importance on economic or social factors when choosing a destination.

1.5 The Role of Private Land Conservation

In recent decades, an increasing trend in PLC has occurred worldwide (Langholz & Lassoie 2001). In the USA, half of the federally listed species have more than 80% of their habitat on private land, which highlights the importance of private conservation action (Fisher & Dills 2012). Internationally there is growing awareness of this importance. At the 2003 World Parks Congress in Durban, the International Union for the Conservation of Nature (IUCN) focused on private conservation with the title 'Benefits beyond boundaries'. During the congress an official definition of privately owned PAs was agreed upon. Following this definition, I define a privately owned PA as “a land parcel of any size that is 1) predominantly managed for biodiversity conservation; 2) protected with or without formal government recognition; and 3) is owned or otherwise secured by individuals, communities, corporations, or NGOs” (IUCN 2005). During the World Parks Congress in Sydney 2014, under the topic 'Parks, people, planet: inspiring solutions', the increasing role of PLC was acknowledged and a commitment was made to "...enhance diversity, quality and vitality in governance and management, including the appropriate recognition and support of areas conserved by Indigenous Peoples, local communities, and private entities" (World Parks Congress 2014).

Assets and Drawbacks

Relying solely on statutory PAs may not ensure the resilience of conservation estates in times of environmental change. Different approaches to PAs, such as the development of conservation networks, buffer zones and corridors are needed for addressing issues of scale (Figgis 2004; Laurance et al. 2012). PLC offers a supplementary solution to current conservation systems that focus on statutory PAs (e.g. Lindsey et al. 2014).

On the positive side, the inclusion of PLCAs in conservation planning will profoundly change target achievement and PA network design (Gallo et al. 2009); this depends, however, on the ability of measuring performance to ensure effectiveness. PLCAs can provide linkages and corridors between statutory PAs to provide a landscape-model with an optimal mix of instruments, incentives and institutions (Rouget et al. 2003b; Knight et al. 2010). Considering PLCAs as a potential solution represents a shift in conservation thinking and action – away from traditional national park boundaries towards conservation strategies for entire landscapes (Figgis 2004; Vimal et al. 2012). In other words, there is a need for concurrent reserve and off-reserve management, and managing the matrix surrounding PAs is essential (Lombard et al. 1999). When diversified and innovative governance and conservation strategies gain further momentum, such management across landscapes will have to be coordinated and performed by different stakeholders and conservation actors, such as governmental authorities, NGOs, conservancies or individuals. Conservation thinking is a precursor and prerequisite for altered conservation action, for example, the global monetary estimates of Ecosystem Services provided to humanity can support a change in awareness and worldview facilitating practical implication of the concept and decision-making at multiple scales (Costanza et al. 2014). In South Africa, conservation thinking changed in the 1960's (see section 1.6, Chapter 1), but globally discourses and targets for conservation and sustainability manifested in the literature and political environment around the 1972 United Nations Conference on the Human Environment in Stockholm, which was followed by the first IUCN report in 1980, the Brundtland Commission in 1984 and the Earth Summit 1992 in Rio de Janeiro.

Focusing on conservation beyond traditional PA boundaries is supported by the trend whereby many areas of significant conservation value are located in high production landscapes. PLCAs hold a strong potential to conserve threatened species and a country's ecosystems and habitats that are not always represented by statutory PAs (Langholz & Lassoie 2001), or to contribute to enhanced landscape connectivity. While PLC helps to prioritize species-specific conservation (Stolton et al. 2014), it also contributes to preservation of habitats. By protecting certain target species, such as individual endangered mammal or plant species, the accompanying habitats in which these species occur also benefit from the protection as a whole. Furthermore, many landowners are willing to commit themselves to both voluntary and formal agreements on long-term conservation (Sims-Castley et al. 2005; Knight et al. 2010).

Timely engagement in PLC can often be achieved (Stolton et al. 2014) because individuals as opposed to whole organisations are involved, and it opens up potential for innovative funding mechanisms. Economic and simultaneous ecological viability can potentially be reached by establishing ecotourism in PLCAs. It can produce economic stability which can subsequently ensure the longer-term persistence of PLCAs. Also, long-term funding for public conservation action is in many cases insufficient and private landholders can play a major role in biodiversity conservation (Cousins et al. 2010). PLCA existence creates positive externalities that accrue to authorities and governments when private funding of conservation action avoids direct public conservation costs (Langholz & Lassoie 2001). For example, game farms in the South African Eastern Cape Province probably have a strong economic impact on the entire region through job creation or community upliftment (Sims-Castley et al. 2005; Langholz & Kerley 2006). Generally, the commercial use of wildlife which is well adapted to the environmental conditions of areas with low rainfall and poor soils (representing poor agri-ecological conditions) presents an option for efficient use of resources and improved livelihoods, especially in marginal lands (Musengezi et al. 2010).

Wildlife enterprises often show higher employment as well as salaries in comparison to the livestock industry (e.g. Langholz & Kerley 2006). From a social and political point of view PLC is an option to involve different stakeholders, in particular citizens, in decision making and resource management (Langholz & Lassoie 2001), both on local as well as on national scales (Stolton et al. 2014). Private landowners and other actors can contribute to conservation with local knowledge and expertise.

Despite these many opportunities and benefits, a critical perspective is necessary in establishing, understanding, and managing private conservation action. PLC faces many challenges in creating and ensuring effectiveness in various aspects (e.g. Holmes 2013). Foremost, it may not guarantee long-term sound management or coordinated decisions due to potentially tenuous status of private properties or lack of communication and knowledge sharing (e.g. Kreuter et al. 2010). Conservation of species and habitats may only be temporary since it is connected to the level of ownership and property rights (Stolton et al. 2014). Sometimes inadequate resources are made available for professional conservation planning and management on PLCAs (Cousins et al. 2008). Or the incentives to use PLC for economic rather than ecological benefits may be stronger. Furthermore, overarching socio-economic conditions, such as fluctuating international tourism or political instabilities, may cause a change in land use. Financial benefits from PLC, or lack of primary economic viability of properties for ecotourism, may also incentivise landowners to rather focus on the introduction of charismatic wildlife or to bias efforts towards certain habitats. This is of concern from an ecological point of view in order to secure the protection of biodiversity (Langholz & Lassoie 2001).

It is also important to consider trade-offs with respect to ecosystem services provision and benefit sharing. Problems may arise in terms of ownership, access and benefit sharing for surrounding communities and populations (e.g. Brooks et al. 2011). In South Africa, a main challenge is to appropriately address the conflicting relationships between the protection of biodiversity, inequitable access to resources, and poverty. A striking example is given by the immediate situation of farm dwellers (Crane 2006; Brooks et al. 2011). Between 1994 and 2008, South Africa underwent a comprehensive process of land restitution and land reform. Land claims were lodged in relation to properties from which people have been relocated under the apartheid regime (James 2000). These land claims affect many statutory PAs (e.g. Ramutsindela 2003; Thondhlana et al. 2011). It is unclear how many of these claims are affecting properties which are under current private ownership and management for wildlife enterprises and biodiversity conservation. In many cases, co-management between the relevant conservation authority and the claimants (who are legally awarded tenure rights) is implemented as approach for reconciling land claims and biodiversity conservation. Since the 1980's, community-based conservation has been important to gain support for and ensure success of PAs (Kreuter et al. 2010). It is, however, doubtful whether these arrangements will be successful and other strategies might be needed (Kepe et al. 2005; Kepe 2008). On the one hand, conservation and ecotourism initiatives which focus on pro-poor tourism and community-based natural resource management can be substantially beneficial to all engaged parties and are increasingly implemented in southern Africa (Spenceley & Seif 2003; Rogerson 2006; Spenceley & Meyer 2012a). Such success is not only valued in economic terms, but includes democratic benefits or cultural and spiritual benefits such as the access to sacred land (e.g. Turner 2004). On the other hand, implementing pro-poor tourism and community-based natural resource management is based on decentralization and participation which require broad reforms (such as transaction transparency; competence, confidence and political sophistication by local institutions; granting of local discretion over environmental decision making; and downwards accountability) (Blaikie 2006). Many of these challenges often make a successful implementation of community-based conservation and pro-poor tourism difficult since they are linked to issues of power and governance (Spenceley & Meyer 2012b). Further, many protected areas face a 'use - conservation gap': different demands and objectives apply to management and usage of a protected area for either tourism or conservation. For example, the introduction of large charismatic species may enhance the attraction of an area as tourism destination but may be a constraint for the rehabilitation of indigenous flora. This gap needs to be bridged in order to achieve sustainability for both natural and cultural resources (Jamal & Stronza 2009). A related example is the establishment of the Great Limpopo Transfrontier Conservation Area which, via an international top-down approach through political and ideological pressures to speed up the process, caused the neglect of adjacent rural areas and their residents (Spierenburg et al. 2012).

Another key issue is governmental regulation and bureaucracy. Overregulation or contradictory legislation with respect to PLC can lead to complications during the establishment or management of PLCAs (Sims-Castley et al. 2005), for example when issuing of permits is faster or easier for livestock such as sheep as compared to wildlife species such as springbok. Many PLCA owners and managers see mandatory authorities (such as CapeNature in the Western Cape Province) as top-down regulators which can lead to imposition of undesirable procedures. In addition, lack of clarity and inconsistency in definitions around PLC and related programmes or legislation contribute to such complications or can cause dissatisfaction and disengagement of landowners. Similarly, there is often lack of support and incentives for PLC which could increase engagement in conservation action when implemented (Paulich 2010; Sorice et al. 2011). Many landowners also do not have the capacity or motivation to engage with conservation policies (Stolton et al. 2014). Addressing these issues could, however, enhance private landowner motivation to engage in conservation action (Selinske et al. 2015).

From an ecological point of view, it is a challenge to ensure adequate quality and quantity of biodiversity in PLC which can be restricted (Jones et al. 2005). Land under biodiversity protection might be disproportionally skewed towards certain species or habitats. But insufficient data and information make an evaluation of the conservation value of PLCAs generally difficult (Kreuter et al. 2010). Especially on game ranches and game reserves, many landowners stock charismatic, extralimital or exotic species due to tourist preferences which often are not indigenous to the area, cause concerns for conservation, and do not necessarily enhance ecotourism success (Maciejewski & Kerley 2014a). These species can be in competition with indigenous wildlife and can cause severe problems for the local flora and fauna, e.g. by being placed in a non-suitable habitat where they overgraze. Also, interbreeding and genetic manipulation occur where species intermix and the gene pool does not stay clean (Lindsey et al. 2009). Closely related to this is the issue of overstocking when more animals are introduced to properties than their actual carrying capacity would allow for. In many cases predators are prosecuted on properties which rely on ecotourism income from game viewing or are engage in wildlife trade and breeding of valuable species (Cousins et al. 2008). PLCAs can potentially also be a source of diseases which can affect both wildlife and domestic livestock in surrounding areas (De Vos et al. 2016a). In relation to this, the often small property size and fencing of PLCAs can lead to several limitations caused by scale-mismatches where PLC operates on too small of a scale for certain processes (Cumming et al. 2015a), such as the need for intensive wildlife management with additional feeding or the interruption of species migration (e.g. Hayward et al. 2007).

Generally, PLC can on the one hand be interpreted as a result of the decentralization of governance in conservation efforts, where mechanisms evolve or are set in place to encourage individual action and new approaches. However, it is questionable whether we are facing a true decentralization, meaning a bottom-up development of independent conservation phenomena, as opposed to rather an augmentation of already existing statutory PA networks which are expanded through top-down formal conservation agreements implemented with different stakeholders. On the other hand, in the discourse around the management of common-pool resources, criticism is raised around the commodification of nature. In relation to conservation, commodification would refer for example to the privatization of conservation land or the valuation of ecosystem services provided. Privatizing conservation land and efforts through property rights may lead to undesirable outcomes, for example where conservation objectives and practices are overpowered by market related measurements of profit or where access and benefit sharing with external stakeholders is restricted. Valuation can be misleading since many ecosystem services either are public goods or stem from ecosystems as common assets. Costanza et al. (2014), for example, clarify that in their research a valuation does not call for privatization but is rather a measure of the benefits provided to society. In the bigger picture, conservation efforts and protected areas are increasingly subject to the dynamics of globalised commodity markets which impacts national and local custodianship and creates ambiguities in decision making about the value of nature (intrinsic and sustainable local use versus utilitarian and commodifying) (Crawhall 2015). In light of the fact that many PAs in developing countries are underfunded and thus do not perform well, commercialization in conservation is not always an evil and can substantially contribute to the protection of biodiversity (de la Harpe 2004).

Uncertainties and disturbances

All these findings still leave a gap which needs to be filled: the overall understanding of PLCAs as SESs. Scientific research about all aspects of private conservation is mostly still in its infancy. PLCAs differ in size, land tenure arrangements, management objectives and type of landholder (Jones et al. 2005), and it is therefore a challenge to identify generalities about their functioning, ecological effectiveness, and social impacts. When looking at PLC as a phenomenon potentially contributing to overall biodiversity conservation, several questions arise and challenges occur at all scales.

How can, at the scale of individual PLCAs, identity be maintained so that conservation is ensured on a long-term basis? From an ecological point of view, it is necessary to gain insights about where PLCAs are located; which habitats and species they protect; and what potential they still hold for further enhancement of biodiversity conservation and accompanying ecosystem services provision. From a social, economic and political point of view, it is important to understand how knowledge about PLC can be both gained and shared; which contextual factors drive PLCA creation, persistence or failure; and how to incorporate PLC into policies and strategies.

At the scale of PA networks across broader landscapes, it is relevant to gain insights about spatial connectivity of reserves; to incorporate PLCAs into conservation networks; and to assess their contribution to conservation targets for specific species, habitats or ecosystem services provided. In which way can PLCAs contribute to other benefit provision such as creating social and economic values (e.g. recreation and employment)? Which external factors at national and global scales influence conservation networks and how do statutory and private conservation efforts differ in their responses?

PLCAs are influenced by relationships and feedbacks of both fast and slow variables, whether internal or external, which can both enhance or decrease desired resilience. Fast and slow variables have shorter or longer turnover times, respectively (Carpenter et al. 2009). Fast variables influence mainly the dynamics of a SES through interactions and feedbacks and respond to the conditions created by slow variables which rather determine the underlying structure of the system (Biggs et al. 2012). Slow variables can for example be natural disease control, climate change, conservation ethics, legal systems or markets. Fast variables can represent for example fluctuations in ecotourism, employment, invasive species or local crime regimes.

Dealing with disturbances and threats to PLCAs refers to monitoring of and responding to changes in both fast and slow variables. For example, decision-making of landowners about longer-term utilisation of their property, e.g. for ecotourism or wildlife breeding, can be determined by a change in economic and political conditions which rather represent slow variables. Implementation of anti-poaching activities in a PLCA, for example, would rather be determined by sudden changes in local crime regimes. Biggs et al. (2015) argue that mainly changes in slow variables have to monitored and responded to in order to maintain resilience, since they can cause non-linear changes or even regime shifts when exceeding thresholds.

1.6 Historical Development and Current Status: Private Land Conservation in southern Africa

Creation of PLCAs is generally driven by various factors and shows different trends around the world. In the USA and Australia, for example, financial incentives, particularly around tax deductions, were found to be influential in promoting PLC (Merenlender et al. 2004; Adams & Moon 2013). In Costa Rica and Paraguay, the formalisation and legal recognition of PLC, publicity and marketing, together with the creation of landowner associations has been important, particularly when it strengthened land owners' tenure (Langholz et al. 2000; Quintana & Morse 2005). In many cases, not only direct formal incentives and policies cause engagement in PLC, but wider contextual factors which are taken into consideration by landowners. In eastern and southern Africa, the economic potential of the ecotourism industry (Carter et al. 2008) and similarly in North America and South Africa the economic shift in rural areas from agriculture towards recreational land uses (Merenlender et al. 2004;

Snijders 2012) are main influences. Furthermore, many individuals are driven by non-economic and non-political reasons for engaging in PLC, such as conservation values and conservation ethics, place attachment, or social learning (e.g. Selinske et al. 2015).

Southern Africa, mainly the countries Namibia, Botswana, Zimbabwe and South Africa, is facing a strong continuous increase of land under private and communal management for wildlife-based use and biodiversity conservation over the past four decades (Carruthers 2008; Child et al. 2012; Cumming et al. 2015a). These two management approaches are not synonymous but overlap widely in their outcomes of protecting species and habitats. Wildlife-based enterprises engage in ecotourism based on safari-type activities, breeding, hunting, or trading of wildlife and wildlife products (focusing mainly on large mammal species) and are often referred to as game ranches or game reserves (e.g. Snijders 2012). Areas under biodiversity conservation also occur in regions where conditions are not suitable for large mammal species. Such areas often focus on non-safari-type activities, specific species or habitat protection, or do not actively manage flora and fauna. They mostly are referred to as nature reserves, retreats or eco-estates. For wildlife-based enterprises, the contribution to biodiversity conservation and development depend on several factors, such as the geographical location of the property, its position in relation to statutory PAs, its size, and the management philosophy and quality (Goodman et al. 2002).

Accurate records regarding land area or number of properties being involved in wildlife-based utilisation and biodiversity conservation are difficult to obtain. The same applies to economic measures for such enterprises. Many assessments are based on estimates, cover the industry only partially, use differing terminology which makes comparisons challenging, or are outdated. Based on different sources of evidence, Krug (2001) argued that approximately 10-20% of private land in southern Africa was under wildlife protection or wildlife management at the beginning of the century. In Zimbabwe, about 20.7% of commercial farmers were involved in some kind of wildlife utilisation already in 1994 (Wolmer 2005). In Namibia, about 15 to 20 percent of freehold farmland was used for commercial game production by 2001 (Krug 2001) and there were more than 500 commercial hunting farms in 2003 (Erb 2004).

Although no comprehensive inventory of PLCAs is currently available for South Africa, Cousins et al. (2008) estimated that there were some 9,000 private wildlife ranches with around 20.5 million hectares of protected land in 2008, representing about 16.8% of the national territory. This estimate has to be interpreted with care, since definitions of PLCAs differ widely across the country and thus a large part of the private conservation estate might not have been accounted for, notably if it is not registered with authorities. By contrast, national parks (SANParks) at that time covered about 5% of South Africa and today (21 national parks) cover about 7% which equals just over 3.75 million hectares (SANParks 2015). Earlier statistics, however, strengthen these estimates and found that in 1993 about 8.5% of the South African agricultural land was used for game farming, which increased to about 13.3% in 2002 (Van der Merwe & Saayman 2005). Such numbers paint a strong contrast to the 1960's when only 10 game farms existed in the country (Van Hoven & Zietsman 1998, in Anderson (2003)).

Besides statutory PAs, the recent increase in PLC is thought to play a vital role in biodiversity conservation for the country. About 79% of the country is in private hands (Department of Rural Development and Land Reform 2013) and many areas of great conservation value are located in high production landscapes of which main parts are privately owned (Gallo et al. 2009). On a provincial level, Goodman et al. (2002) for KwaZulu-Natal reported that 6.7% of the province was under game ranches. According to Bothma (2002, in Van der Merwe & Saayman (2003)) there was a 2.5 % increase in land utilised for game farming from 1998 to 1999 which translates into a 300.000 ha per year increase for the purpose of game farming tourism. This estimate is in line with more recent ones, where the South African game ranching sector has expanded at between 5% and 20% annually in the last decade (Child et al. 2012).

Anderson (2003) estimated the gross economic value of the wildlife market in South Africa to be around R1.4 billion based on 2001 prices (including hunting, wildlife-viewing tourism, live game sales, and wildlife products and processes). The turnover alone at wildlife auctions increased from around R17 million in 1991 to R81 million in 2001 (in 2000 prices) (Anderson 2003). According to Van der Merwe & Saayman (2003), in South Africa trophy hunting on a national level was the biggest revenue earner (R532 million). Live animal sales ranked second (R180 million), followed by ecotourism (R106 million) and processed game products (R93 million).

The strong development of PLC in Southern Africa is based on both consumptive and non-consumptive uses of wildlife and landscapes. Landowners have to create and capture values through the attributes provided by their properties. These derived values and benefits are of tangible and intangible character. Market-based values are mainly generated by four key activities, namely ecotourism, hunting, breeding of valuable species and processed game products, such as meat, hides, skins, ivory and live sales (Barnes 1998; ABSA 2003; Van der Merwe & Saayman 2005). Non-market values include for example recreation, education and research, conservation of endangered species or maintenance of scenic habitats (Barany et al. 2001; De Vos et al. 2016b).

Countries in southern Africa have historically undergone similar developments and still reflect similar contexts in relation to PLC which I will subsequently discuss for South Africa as the country of focus for my research. Here, the ongoing establishment of PLCAs is driven by both currently well-defined property rights over land and wildlife (which allow landowners to enclose animals on their properties and make use of game trade and wildlife products) and an economically viable wildlife market (based on international demand for ecotourism and local demand for venison).

Colonisation of southern Africa had led to severe reductions and even extinction of indigenous large mammal species in the 19th and 20th Century (Carruthers 2008; Bothma et al. 2009). Causes were a lifestyle and culture of intensive hunting, extensive habitat use for livestock, and disease epidemics as well as the persecution of wildlife such as predators. Hunting and diseases, such as rinderpest, caused severe losses of both domestic and wildlife stocks at the end of the 19th century (Cumming 1991). To avoid further epidemics, wild and domestic ungulates were then separated from each other through fencing (D'Amico et al. 2004). Commercial use of wildlife was not allowed and wildlife was kept in established PAs (Cumming 2004). By that time and due to the dwindled numbers of wild animals, private landowners came to value game on their properties for aesthetic and recreational significance. Bothma et al. (2009) found the desire to provide retreats for personal enjoyment to be an initial stimulus for wildlife utilisation on private lands, however, motivations diversified and incorporate conservation, profit and the sustainability compared to conventional agriculture.

The strong increase in commercial and private use of wildlife dates back to the 1960's when legislative changes allocated rights to private landowners to manage and make use of wildlife on their land (Bond et al. 2004; Carruthers 2008). Current conditions stem from a shift in land use from former livestock farming (cattle, sheep, goats) to wildlife-based enterprises (game ranching, ecotourism with game viewing, etc.) This shift took place due to a combination of several social, ecological, economic and political drivers (Carruthers 2008; Bothma et al. 2009; Cousins et al. 2010; Green 2010). Social factors included a change in perception and valuation of landscapes and wildlife, a decreasing interest of the younger generation in livestock farming, a growing public conservation ethic, and blooming international tourism. A main ecological factor was the enhanced understanding of wildlife disease dynamics. Economically, a decreasing profitability of and removal of subsidies for livestock farming and increased income potential from trophy hunting played an important role for PLC. Changes in wildlife possession rights (decentralisation of authority) and democratic policies allowed for a more reliable climate to private investments and business.

The legislative changes resulted in a diversification of the scale, type, and ownership of PAs in southern Africa. PAs now include a diversity of private, communal, and governmental initiatives and range from small-scale PAs (< 15 000 ha) to large scale PAs. The latter are representative for recent trends in conservation which lead to the creation of conservancies (in which several landowners collaborate and remove fences between their properties), the enhanced establishment of multi-species systems, and the implementation of transfrontier-conservation areas such as the Great Limpopo Transfrontier Conservation Area with about 90.000 km2 (Cumming et al. 2015a).

The recent phenomenon of a strongly increasing emergence of PLC is of vital importance for South Africa. The country still has to deal with societal challenges of poverty and equity which cannot be separated from conservation (Jones et al. 2005). New approaches for conservation across landscapes and beyond traditional boundaries (Figgis 2004; Laurance et al. 2012), including community-based concepts, ecotourism, and incentives for the provision of ecosystem services, can help to address these issues - if sustainably developed and applied. Notably, ecotourism offers a strong business opportunity for investment and development (Binns & Nel 2002). Nature-based tourism was contributing about as much to the gross domestic product of southern Africa as agriculture, forestry and fisheries combined already by the turn of the century (Scholes & Biggs 2004).

In South Africa, PLCAs can fall under the category of protected environments (Government of South Africa 2004). The definition supports the trend of new conservation strategies outside traditional PAs and of implementing solutions for entire landscapes. Protected environments are declared: "(a) to regulate the area as a buffer zone (…); (b) to enable owners of land to take collective action to conserve biodiversity (…); (c) to protect the area if the area is sensitive to development due to its - (i) biological diversity; (ii) natural characteristics; (iii) scientific, cultural, historical, archaeological or geological value; (iv) scenic and landscape value; or (v) provision of environmental goods and services; (d) to protect a specific ecosystem (…); (e) to ensure that the use of natural resources in the area is sustainable; or (f) to control change in land use in the area (…) ."

These definitions, however, are rather vague and leave space for different PLCA types. Some are community-managed, others set up by conservation trusts, single NGOs, companies or private persons. There is a wide range in approaches of management and ownership of PLCAs which creates high complexity in contextualization and assessment (Carter et al. 2008).

1.7 Study Rationale

Human activities have tremendous impact on biodiversity and ecosystems across the globe (Steffen et al. 2004; Lambin & Geist 2006). It is apparent that our use of the biosphere is no longer sustainable. Humans need to operate within Earth's boundaries to ensure a sustainable future and to secure and enhance ecosystem services provision which is basis for human well-being (Millennium Ecosystem Assessment 2005; Rockström et al. 2009). A pressing problem is the ongoing lack of recognition that ecosystems and social systems are dynamic and interlinked, representing coupled SESs. Dynamic linkages occur within and across scales, and SESs are subject to different temporal dynamics due to fast variables (e.g. law enforcement) and slow variables (e.g. trust in human society). Mostly, slow variables determine shifts between different system states through dampening feedback which counteracts disturbances (Holling 2001; Walker et al. 2006). Beyond the lack of recognition of resilience thinking, the question arises whether governments are suitably equipped to manage conservation or whether governance approaches have to be diversified. In South Africa, total state conserved area is below global CBD targets and thus the country needs an expansion of private or statutory areas to meet conservation goals.

Society faces a need for preventing undesired shifts in SESs, dealing with future uncertainty, and addressing a limited understanding of the vulnerability of the biosphere generated by human-induced changes (Moberg & Simonsen 2015). Vulnerability of the biosphere is likely to be enhanced through conventional state government models in conservation by which all 'eggs are put into one basket'. Policy innovations, such as decentralised governance and community-based conservation, are expected to strengthen the sustainable use of common-pool resources and conservation outcomes (e.g. Agrawal 2003). Increased knowledge is needed on how to strengthen desired resilience in SESs. A stronger emphasis should be put on combining human use of natural resources with biodiversity conservation. Focused management and governance of ecosystems is important to maintain and strengthen their capacity to generate essential services (Moberg & Simonsen 2015).

The SES concept is useful with respect to conservation and PAs since PAs incorporate key elements, interactions among these elements, and are situated in a local environment. For maintaining and improving PAs it is highly relevant to understand the impacts of different perturbations which can change PA characteristics and cause sudden transitions into possibly undesired regimes. Conservation and PA management has to incorporate a SES perspective, recognizing cross-scale interactions, into a dynamic model in order to identify opportunities for maintaining or enhancing the desired resilience of PAs and the entire conservation system.

A better understanding of PAs as SESs is important and can be achieved through a hierarchical, cross-scale and multilevel assessment approach. Anderies et al. (2004), for example, offer a framework to assess SESs by addressing three issues (resource, governance system and associated infrastructure). The framework identifies system components and influencing disturbances and applies variables around entities and links involved in the system. Many conservation challenges arise when conservation action is undertaken which does not reflect the scale at which a problem needs to be solved (Guerrero et al. 2013) or when issues related to governance and socio-economic contexts are addressed primarily through a biological lens. Scale mismatches have to be avoided. Therefore, at least three, possibly five, levels of institutional organization should be addressed when investigating PAs (Cumming et al. 2015b). At the lowest levels, individual PAs and even sub-PA units (e.g. a certain habitat type within a PA) are subject to analysis. An understanding of how to maintain PA identity in both social and ecological terms is the focus at this scale, e.g. how to maintain habitat and species diversity, diversify income sources, or deal with disturbances such as disease outbreak or economic crisis. At a meso, regional scale it is relevant to analyse social-ecological connectivity and the surrounding context of PAs, e.g. spatial linkages of habitat patches or collaboration among stakeholders (Prugh et al. 2008; Cooke et al. 2012). At the highest levels, national and global, mainly dynamics of power, governance, and economies have to be investigated which influence social-ecological contexts on lower levels. Generally, ecological processes more directly influence PAs at meso and finer scales whereas socio-economic drivers dominate at broader scales (Cumming et al. 2015b).

PAs often function as networks within a wider conservation system. Many interactions take place on similar scales but flows of material and information between nested elements determine the patterns and dynamics at different scales. Such flows can substantially influence or change the structure and functioning of PAs. Identifying drivers and feedbacks can help to prevent management problems and to coordinate responses to threats. PAs can contribute to desired regional resilience and regional resilience may influence individual PAs (Cumming et al. 2015b). For example, ecotourism in PAs can attract many visitors which not only secures the financial viability of a single PA but can create economic upliftment in the surrounding landscape (Barany et al. 2001; Sims-Castley et al. 2005). Being connected to other PAs in a regional well-functioning conservation network, which enhances transfer of vital information and recourses, can contribute to individual PA and thus to conservation success (Vance-Borland & Holley 2011).

Generally, conservation systems need to build capacity to deal with change, uncertainty, and surprise to maintain or enhance desired resilience and to provide ecosystem services to society. Building this capacity and desired resilience can be achieved with seven principles: maintaining diversity and redundancy, managing connectivity, managing slow variables and feedbacks, fostering complex adaptive system thinking, encouraging learning, broadening participation, and promoting polycentric governance systems (Biggs et al. 2015).

In light of the impermanence of many statutory PAs which are subject to downsizing, downgrading, or even degazettement there is a strong need for conservation action beyond traditional PA boundaries (Mascia & Pailler 2010; Vimal et al. 2012). The continuous global increase of PLC shows a trend of diversification in conservation strategies: PLC provides a new model that can incorporate all kinds of stakeholders and strategies across the entire landscape (Figgis 2004). An understanding of PLC is therefore important to develop and apply sustainable conservation strategies. But little is still known about the emergence, functioning and persistence of PLCAs as well as how top-down governmental strategies can best be combined with private conservation action.

For South Africa such an understanding is important with respect to PLC contributions to national fulfilment of the Millennium Development Goals (UN 2015). My project therefore focused on the interactions of people and ecosystems in, around, and between the PLCAs of the Western Cape Province as case study.

1.8 Objectives and Hypotheses

The aims of my study were 1) to assess and better understand the structure and functioning of PLCAs in the Western Cape Province, and based on this assessment 2) to identify generalities of PLCAs as SESs which could be valid beyond provincial and national borders.
In addressing these two aims I made use of the concept that SESs can be characterized through key elements of system identity (Cumming et al. 2005). I did not methodically test the identity framework itself, however, conducted a holistic assessment of representative measures and discussion of PLC in the study area and in relation to other regions in the world. In my research I further did not directly analyse resilience of PLC and do not claim to make any argument based on my results as to whether or not and in which ways PLCAs are currently resilient. A better understanding of system identity rather allowed discussing and highlighting the potential and ways of building, enhancing, and ensuring resilience of PLCAs.

I expected location and spatial variation in social-ecological factors to strongly influence PLCAs in their identity. Furthermore, I expected PLCAs to provide a substantial contribution to the current South African conservation estate. The study objectives were determined by addressing the following key questions which led to specific hypotheses to be tested:

1) Does a typology of PLCAs exist in the Western Cape Province and is it influenced by geographical location? I hypothesized that at least two distinct PLCA types (i.e. corporate models focusing on different ecological and socio-economic features) exist and that they emerge because biophysical conditions and geographical location determine their corporate models (Chapter 3).
2) How does spatial location influence the interactions among PLCAs as well as other stakeholders? I hypothesized that nearest neighbour effects are important in PLC networks because they determine social bonds or enhance collaboration based on similar habitat types or close proximity (Chapter 4).
3) Which factors drive visitation rates to PLCAs? I hypothesized that socio-economic factors play an important role in ecotourism because ecological features alone do not account for the utilisation and valuation of cultural ecosystem services (Chapter 5).
4) What is the contribution of the private conservation estate to conservation? I hypothesized that particularly non-formal PLCAs contribute substantially because they occur in areas of high importance for biodiversity conservation (Chapter 6).

The Discussion (Chapter 7) highlights insights about PLCA identity from all individual chapters and concludes on potentials for building desired resilience in PLC. I also discuss the suitability of the applied identity framework itself.

1.9 Terminology and Methodology

Terminology

Many different definitions of privately owned PAs exist around the world and terminology is not applied uniformly (IUCN 2005; Carter et al. 2008). The general term Private Land Conservation (PLC) is thus increasingly used in the research literature (Cooke et al. 2012; Selinske et al. 2015). It incorporates privately owned conservation areas of different types and status and at least enables to distinguish private from other conservation efforts whereas it does not help to clarify or specify the topic any further.

According to the IUCN definition as well as South African legislation, for example, only formally protected private land should be termed ‘private protected area (PPA)’ and non-formally protected land described as ‘private conservation areas’. I subsequently do not distinguish between these terms since legal status of my study participants was but one aspect without major influence on my assessment in the Western Cape Province, unless stated otherwise (Chapter 6). Also, legal status does not necessarily represent a meaningful indicator for a classification of PAs. Other approaches looking at biodiversity performance or the political interest in conservation areas and their benefit provision might be more pressing. I apply the term Private Land Conservation Area (PLCA), including both formally protected and non-formally protected private conservation land, throughout the study (Table 1).

Table 1: Terminology in relation to protected areas as applied throughout the thesis

Term	*Description*
Private Land Conservation (PLC)	Refers to conservation efforts and action by non-statutory actors (e.g. private landowners, NGOs, communities)
Private Land Conservation Area (PLCA)	Refers to protected areas (of different type and status) under non-statutory ownership and management (e.g. private, NGO or communal properties)
Stewardship site	Refers to PLCAs which are registered in the Stewardship Programme of the Western Cape provincial conservation authority, CapeNature. a) contract reserves: legally binding conservation area, formally protected b) biodiversity agreement and c) voluntary conservation area: weaker legal status, recognized but not formally protected
Statutory protected area (statutory PA)	Refers to protected areas under governmental ownership and management (e.g. national parks, provincial nature reserves, mountain catchment areas, state forest, etc.)

Across South Africa, provincial government departments and other conservation authorities and stakeholders keep inventories and databases about PLCAs. However, this information is often rather incomplete or outdated and does not adequately represent the current status of PLC in the country also due to not being consolidated into a single dynamic inventory. Therefore, many PLCAs might be formally registered with authorities but may in the meantime have changed land use or ownership.

Specific to the Western Cape Province is the Stewardship Programme managed by the provincial conservation authority, CapeNature. This programme collaborates with private landowners to dedicate their land to biodiversity conservation (Cape Nature 2015). ‘Stewardship sites’ include several types of land protection according to how legally binding the collaboration is. Contract reserves are legally binding, biodiversity agreements and voluntary conservation areas are recognized (registered within the programme) but have a weaker legal status.

Furthermore, I subsequently make use of the term ‘statutory PA’ when referring to protected areas under governmental management (i.e. national parks, provincial PAs and similar).

Study Participants

The most important criterion for selection of study participants was that they were open to the public and engaged in ecotourism. All PLCAs which were selected for data collection catered for both local and international visitors, no matter whether they stocked charismatic wildlife or not. The selection process was not further biased by other PLCA characteristics such as specific area size, features, or legal status. PLCAs from across the entire province were included in the study (Figure 2).

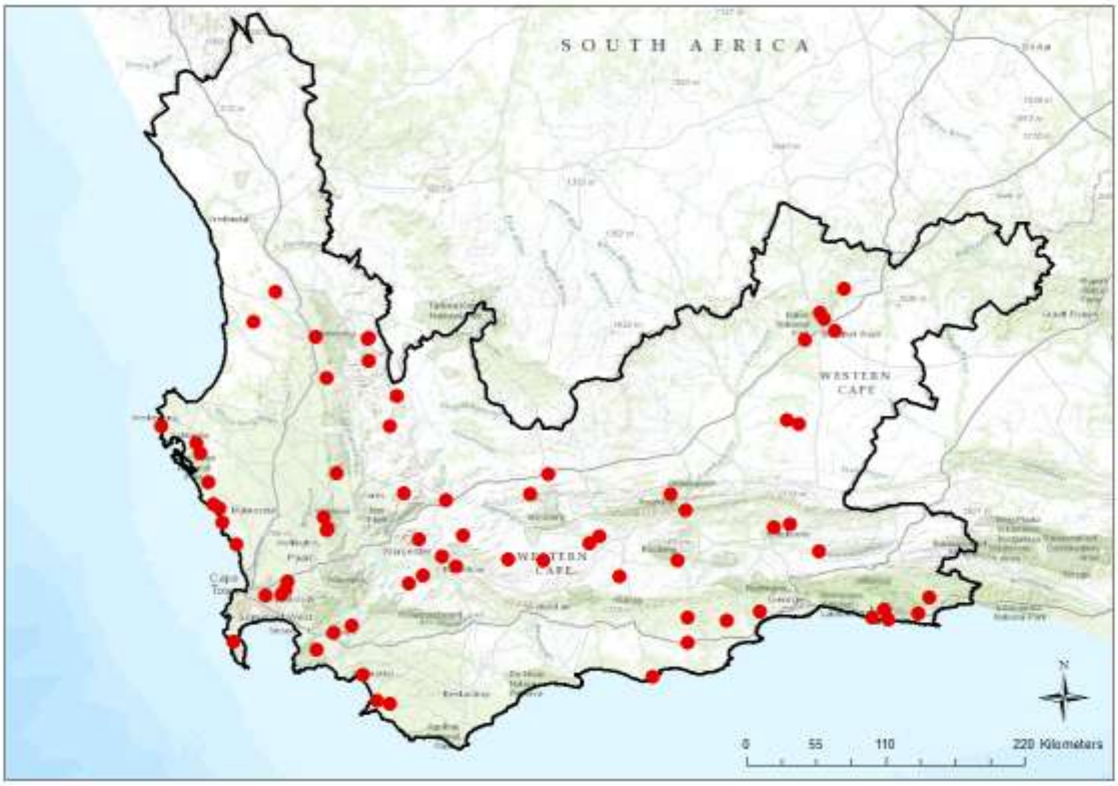


Figure 2: Location of 70 study participants in the Western Cape Province, indicated by red dots

Potential study participants were identified by several methods. At the start of the research project, the aim was to collect data from a minimum of 20 PLCAs. This preliminary sample of 20 PLCAs was identified using an online search engine. The search revealed mainly well-marketed large PLCAs with strong safari-type ecotourism and introduced charismatic wildlife. When it became apparent that several PLCAs without stocked charismatic wildlife exist, the online search was modified using different keywords (e.g. ‘nature reserve’ or ‘retreat’ instead of ‘game reserve’ or ‘game lodge’) in order to identify the entire range of potential study participants. Furthermore, many participants provided referral contacts to other PLCAs and the sample could thus easily be expanded in relation to space and characteristics of PLCAs. Soon it became apparent that a far larger sample size than 20 PLCAs could be anticipated and I tried to balance the selection of participants between PLCAs which either did or did not stock charismatic wildlife.

Participants were initially contacted via email and phone to confirm participation. Of 103 contacted potential participants, 75 PLCAs (see Appendix) fully completed the process of data collection (interview and providing additional data during follow-up), giving a success rate of 73%. The non-participating PLCAs were either not open to the public any more, had changed the purpose of their area, were not interested in participation, did not have time, or never responded to the request. During data preparation for analyses five participants turned out to still not fulfil all criteria correctly (since they had no regular visitation rates either not being fully established yet or being eco-estates) and were thus excluded from analyses, providing a final sample of 70 PLCAs (Figure 2).

PLCA Population and Sample Size

In order to identify the number of active PLCAs in the Western Cape Province and to estimate the representation of my study sample, I conducted repeated online searches over a 2-year time period, gathered information provided by study participants and compared these findings to existing datasets, as described below.

In the Western Cape Province approximately 250-300 PLCAs are officially gazetted in inventories and databases (Figure 3) (De Vos 2014). Some of these gazetted areas still hold the former status of 'Private Nature Reserve', also referred to as Old Ordinance, which was applicable prior to 2003 legislation. Further, it is not clear which of these areas are under ongoing management for wildlife utilisation or biodiversity conservation or changed land use since they had been gazetted. Thus, all gazetted private reserves are re-assessed via the Stewardship Programme of the provincial conservation authority, CapeNature (Figure 4). In December 2013, their inventory comprised 176 re-assessed sites which now hold an active status and are listed as some form of reserve, according to reserve types as defined within the Programme (Purnell 2014; Cape Nature 2015). Eighteen PLCAs of my sample were listed under the Stewardship Programme either as contract nature reserves, biodiversity agreements or voluntary conservation areas whereas the rest (52) were not engaged at all (see Chapter 6).

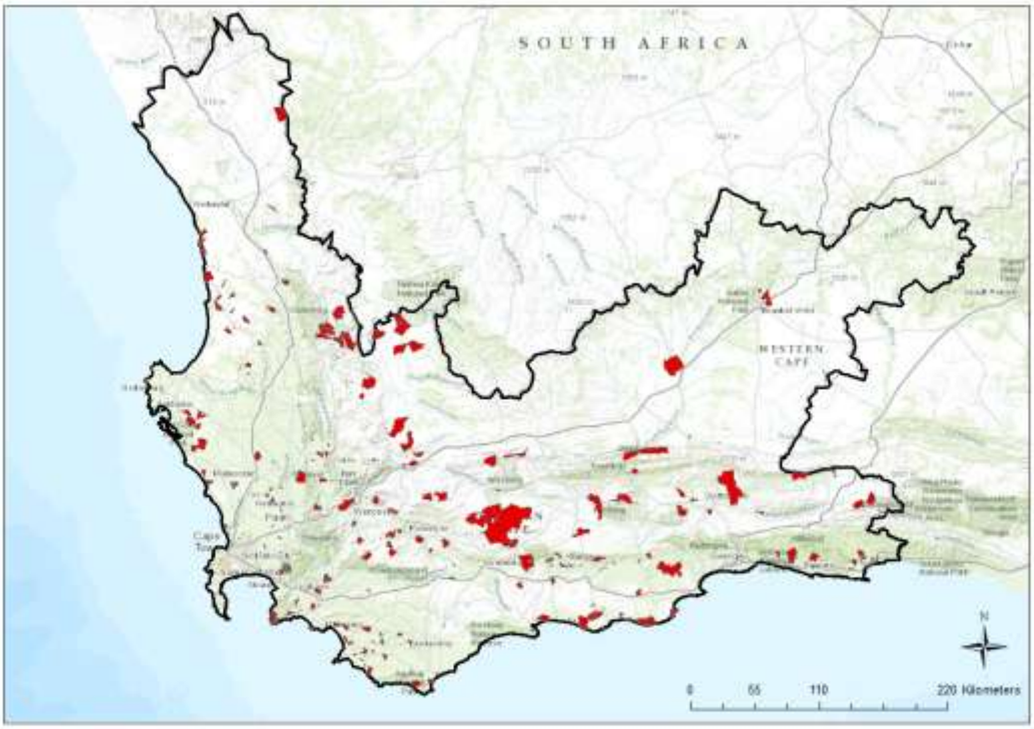


Figure 3: Distribution of officially gazetted PLCAs in the Western Cape Province, depicted in red (De Vos 2014)**. These include areas under Old Ordinance which are being re-assessed by the Stewardship Programme (see Figure 3).**

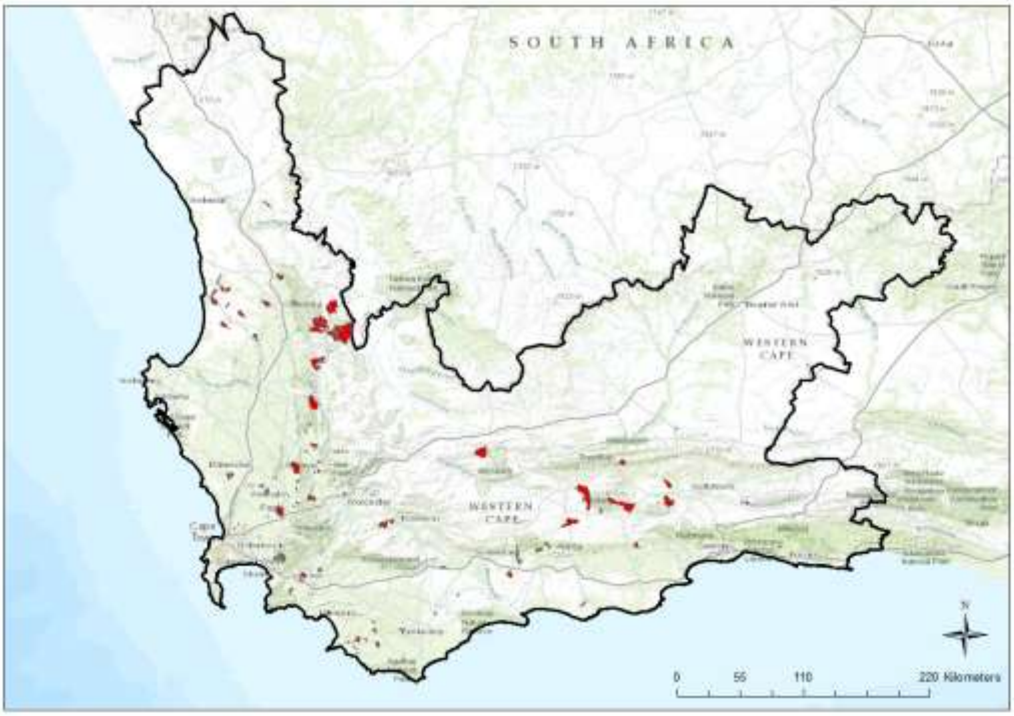


Figure 4: Distribution of 115 gazetted re-assessed Stewardship sites in the Western Cape Province, depicted in red, according to the official inventory from August 2013 (Purnell 2014)**. These also include BWI members which might not represent PLCAs engaging in ecotourism as to my definition of study participants.**

Comparing online searches, additional information and datasets, I could in total identify around 130 PLCAs in the Western Cape Province (whether or not legally recognized) which are currently represented via an online website, being active and accessible to the public, and catering for ecotourism (which was main criterion for study participant selection for my research). Thus, this number does not include areas which are part of larger wine estates or other farms and often participate in WWF's *Biodiversity and Wine Initiative*. The BWI applies sustainability and conservation objectives to agricultural activities of the wine industry and often leads to the engagement of landowners with the Stewardship Programme. Eighteen PLCAs of my sample were recognized via the Stewardship Programme in different categories of protection. The inventory of BWI members can be accessed separately via the WWF website (WWF South Africa 2015). My research directly assessing 70 study participants across the Western Cape Province thus represents about 54% of the overall PLCA population actively pursuing biodiversity conservation and wildlife-based utilisation on their properties while catering for ecotourism.

Data Collection

As general primary method for data collection, I conducted face-to-face semi-structured interviews in English on-site with one representative (managing owner or manager) of 75 PLCAs in the Western Cape Province (e.g. Pasquini et al. 2009; Selinske et al. 2014). These interviews took place from September 2012 to June 2014 and provided the main dataset used for analyses throughout the whole thesis. Ethics clearance for this research was obtained from the Faculty of Science Research Ethics Committee at University of Cape Town.

Three questionnaires (see Appendix) were used: 1) a General Questionnaire, divided into several sections addressing topics such as PLCA characteristics, ecology, tourism, management, interactions, finances and future development; 2) an Interaction Questionnaire, for additional and more detailed information about collaborations and 3) a Financial Questionnaire. Interview questionnaires were reviewed prior to use by two experts who were personally experienced in conducting face-to-face interviews with private landowners in social-ecological research projects. Further, an interview dry-run was conducted with a potential study participant in order to refine the questionnaires based on their feedback and insight. The questionnaires comprised mainly closed-ended questions. Likert scales were used to obtain rated answers on a scale from 1 (not relevant) to 5 (very important). Ratings allowed for a rigorous quantitative analysis. A few open-ended questions were included to also allow for qualitative analysis. Interview data were captured in Microsoft Access, version 2010.

In addition to the data obtained during interviews, study participants provided property boundaries. These were verified via different tools and sources (De Vos (2014), Google Maps, SANBI 2016, Chief Surveyor General (2016)).

In each subsequent chapter I extracted specific suitable data for analyses from the overall dataset derived through interviews. Depending on research questions and type of corresponding analyses I further complemented the interview data by spatial data (e.g. derived from GIS analyses, Google) or other information, as specified in the individual method section within each chapter.

1.10 Thesis Summary

I sought to assess PLC identity holistically based on four elements, namely components; relationships; sources of continuity; and sources of innovation. Data used for analyses were provided by owners and managers of PLCAs in the Western Cape Province during face-to-face interviews. A comprehensive dataset incorporating information about socio-economic and ecological characteristics of PLCAs was obtained and was further combined with spatial and other datasets through various methods.

Before addressing the individual elements of PLCA identity, I conducted a general assessment of private conservation in South Africa, and in the Western Cape Province (Chapter 1 and 2). I investigated the historic development and current situation of PLC on a national and provincial level. A sample of PLCAs, located in the Western Cape Province, served to describe basic system characteristics. Findings were put in context by comparison to studies from other regions. This approach provided a broad introductory understanding of PLC and its dynamics.

PLCA identity was then investigated more in depth based on system components, the first element of identity (Chapter 3). In the Western Cape Province, PLCAs could primarily be distinguished into two groups according to whether or not they were stocking large mammals. This finding raised the question whether or not they could also be significantly distinguished by other characteristics, i.e. whether or not two distinct PLCA types existed. I utilised principal components analysis and clustering analysis as analytical approaches. Furthermore, I investigated whether or not spatial factors influenced the potential PLCA types.

Relationships, as the second element of system identity, were explored by assessing interaction among PLCAs as well as other stakeholders (Chapter 4). I applied social network analysis to better understand patterns and dynamics of conservation collaboration in the Western Cape Province. I focused on whether or not interaction was influenced by the potential PLCA typology as well as geographical location.

Sources of continuity, as the third element of identity, could be understood by analysing ecotourism in PLCAs as one representative measure (Chapter 5). Ecotourism, in particular the income derived from ecotourism, represents a potential measure for future economic viability and thus continuity of PLC. I used variance partitioning and general linear mixed models to identify factors determining variation in tourist visitation rates to PLCAs in the Western Cape Province. Again, I also assessed whether or not the potential typology and geographic location influenced dynamics.

Finally, the contribution of PLCAs to biodiversity conservation in the Western Cape Province was investigated, addressing the question of why and how PLC may be relevant in complementing statutory PA networks (Chapter 6). I used spatial analyses to assess whether or not PLCAs in the Western Cape Province were located in relevant areas for biodiversity conservation. I further investigated whether or not and to what extent they protected critical biodiversity areas and assessed the threat status of ecosystems covered by PLCAs, in comparison to statutory PAs in the province. Furthermore, I discussed the potential future threats and challenges which landowners were concerned about. Combining my findings allowed for an identification of PLCAs as potential target for future conservation strategies.

All individual chapters focussed on assessing one representative measure for the elements of system identity. In Chapters 3, 4, and 5 I could explicitly assess PLCA components, relationships, and sources of continuity. Chapter 6 highlighted why and how PLC is important for conservation and discusses the potential future threats landowners and managers are concerned about, which both refers to sources of continuity as well as innovation. The latter, however, was not explicitly assessed in an individual chapter and rather concluded upon in the final discussion chapter. Also, all individual chapters contain some insights about several identity elements simultaneously since all identity elements are interlinked and cannot easily be separated from each other.

Results from all chapters were thus synthesized in the Discussion (Chapter 7). Linking individual identity elements and highlighting relevant influencing factors provided for a better understanding of overall structure and functioning in the PLC system of the Western Cape

Province. Sources of innovation, as fourth element of identity, were mainly addressed and discussed here by identifying opportunities and potential for ensuring and enhancing desired PLC resilience. Additionally, future research needs were identified.

By investigating PLC holistically and across scales (i.e. individual PA identity, regional networks, dynamics of ecotourism, contribution to conservation) my study contributes to filling both practical and theoretical knowledge gaps. It highlights opportunities for more effective PLC in the study region, and advances insights into the spatial resilience of SESs.

Chapter 2: Private Land Conservation in the Western Cape Province of South Africa

2.1 Introduction

Globally, Private Land Conservation (PLC) and other forms of private conservation action are of increasing importance for maintaining and expanding the conservation estate (Barnard et al. 1998; Fitzsimons & Wescott 2001; Child et al. 2013). Information about Private Land Conservation Areas (PLCAs), however, is still not sufficient for South Africa, and is particularly scarce for the Western Cape Province. Several governmental departments and other organizations maintain records of PLCAs in the province, however, to my knowledge no single comprehensive inventory exists which is accurate to date (see section 1.9, Chapter 1). Only few research studies are available for the province which were conducted focusing on either certain aspects of PLC (such as attitudes and motivations) or geographical regions.

In one study, private landowners' opinions about existing conservation policies, their relationships with local authorities, and their preferences for incentives in the Little Karoo region were assessed (Pasquini et al. 2009). The authors found that conservation policies for private lands could benefit from providing more extension services, forming groups of stakeholders, and publicly acknowledging the contribution of private action to conservation. Cowling et al. (1999) argued that statutory PAs will probably not be able to protect the succulent karoo biome sufficiently and emphasized the importance of off-reserve management and alternative biodiversity-friendly land-uses, such as biosphere reserves. Furthermore, despite the increasing implementation of contractual as well as non-binding conservation agreements with private landowners, the time frames in which conservation goals can be met for the Cape Lowlands are much longer than expected (Von Hase et al. 2010). In the Agulhas Plain, achieving conservation goals will likely depend strongly on the enhancement of private conservation action. PLC needs to be based on agreements with, and incentives for, landowners (Pence et al. 2003). Selinske et al. (2014) assessed the motivation and satisfaction of landowners participating in stewardship programmes as implemented by the provincial conservation agency, CapeNature. Conservation, place attachment, and social learning are the most important factors and "understanding the relationship between motivations, satisfaction, and commitment is necessary for a successful retention strategy in any conservation programme, especially on private lands".

There is still a lack of an overall understanding of PLCAs for the Western Cape Province. No comprehensive analysis of the private conservation estate as an entire system has yet been conducted in order to provide insight into the identity and spatial resilience of PLCAs in the region. Also, no study so far assessed different PLCA types in detail.

Such insights are relevant in order to enhance the effectiveness of PLC and to find successful solutions for collaboration and support mechanisms. For example, landowners and managers of PLCAs may follow differing objectives or management guidelines, possibly according to PLCA type (e.g. whether or not they stock charismatic species, whether or not they cater for ecotourism), and therefore would need specific support to achieve the desired outcome. More detailed knowledge about regional PLC would allow for better coordination either top-down (via authorities e.g. providing incentives, extension services or incorporating PLCAs into conservation planning and strategies) or bottom-up (e.g. via self-organizing in PLCA networks, creation of conservancies or other types of direct collaboration). Such knowledge furthermore is not only valuable to landowners, managers or authorities directly involved, but can provide meaningful information to other stakeholders and sectors which are making use of markets or benefits created by PLC (such as the ecotourism industry, the hunting or wildlife trade industry, the educational and research sector among others).

Assessing PLCAs through the lens of social-ecological systems (SESs) in general helps to address the complexity of the system. PLCAs as SESs incorporate key ecological and socio-economic elements and dynamic interactions between these elements occur across scales. Furthermore, they are embedded in a local context which also influences their structure and functioning (Cumming et al. 2015b). All these aspects have to be accounted for in order to better understand PLC structure and functioning, and to identify options for maintaining and building desired resilience. This means, to better understand how reliability of PLCAs in service provision and their accountability in management actions can be strengthened. Referring again to the concept of system identity (see section 1.3, Chapter 1), I therefore assessed the characteristics of PLC in the Western Cape Province, representing the first element of identity, in order to obtain a better understanding and as basis for an overall discussion of opportunities and challenges.

2.1.1 Study Area

The Western Cape Province of South Africa is an area of high conservation value. It is home to three of the major South African biomes, namely Fynbos, Succulent Karoo, and Thicket. On a finer scale, it comprises six different vegetation units: coastal vegetation, lowland Fynbos, midland-upland Fynbos, Renosterveld, Succulent Karoo and Thicket (SANBI 2015). Notably, the Cape Floral Kingdom with its Cape Floristic Region is one of the world's 25 biodiversity hotspots (Myers et al. 2000), giving South Africa a special responsibility in developing conservation strategies to preserve the extraordinary high diversity and endemism of vascular plants .

Statutory PAs in the Western Cape Province (national parks, provincial nature reserves and similar) protect more than 11,000 km² land area of the province (Figure 1). However, alongside these statutory PAs, many private and co-managed conservation areas exist as described in more detail in section 1.9, Chapter 1.

The Western Cape Province was historically not a typical province for wildlife farming and is not home to many game ranches or game reserves. In contrast, other provinces such as Limpopo Province or Northern Cape Province have long histories of wildlife-based enterprises (Van der Waal & Dekker 2000; Van der Merwe & Saayman 2003). They are major representatives of large-scale wildlife ranches which are aggregated in the association of WRSA (Wildlife Ranching South Africa). Limpopo Province comprises approximately 49% and Northern Cape Province 19.5% of all South African game ranches (Anderson 2003).

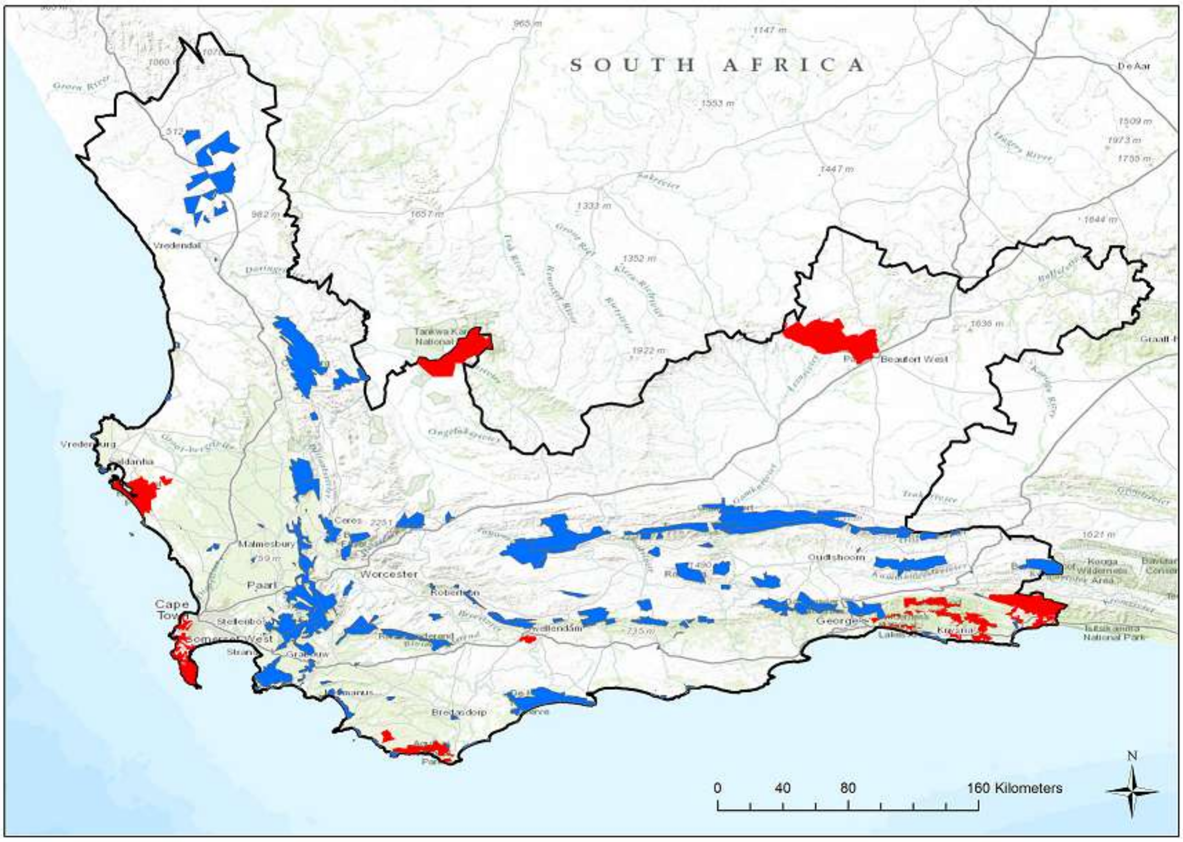


Figure 1: Distribution of statutory protected areas in the Western Cape Province, depicted in red (data source: WCBF2014 (SANBI 2016)**). National Parks depicted in red, provincial reserves in blue**

Most PLCAs in the Western Cape Province have been established during the past two to three decades. They represent a wide range of characteristics such as tenure type, size, age, economic settings, ecological features or ecotourism. Many landowners also get involved in conservancies. Currently there are 70 conservancies existing across the Western Cape Province, which are represented via an initiative called Conservation at Work (Conservation at Work 2015).

The context of the Western Cape Province highlights the importance of PLC in contributing to biodiversity conservation. Comprehensive datasets are needed for detailed analyses of patterns and processes for an improved understanding of private conservation. Personal interviews with stakeholders provided a suitable tool for obtaining such data.

2.2 Data and Methods

Data used for analyses of PLCA characteristics in the Western Cape Province were extracted from the comprehensive dataset obtained during interviews with 70 study participants (as described in section 1.9, Chapter 1).

Data representing many different characteristics were assessed in order to present a wide range of insights into PLC in the study area. Ecological characteristics comprised information about the size of PLCAs, represented habitat types, importance ranking of habitat types, type and number of mammal species, management problems, free roaming predators, type and number of invasive plant species and reasons for potential expansion of PLCAs. Socio-economic characteristics comprised information about the age, former land use, reasons for establishment of PLCAs, number and type of visitors, number and type of facilities and activities offered, employment and staff members, overall economic settings, income and expense types, future management objectives and risk of PLCA failure.

PLCA characteristics were assessed using descriptive statistics. In addition, I assessed the conservation of vegetation units provided by PLCAs in ArcGIS, version 10.0 using the South African vegetation map, updated version 2012 beta (SANBI 2016). With respect to protected wildlife, it would have been interesting to compare the abundance of large mammal species between PLCAs and statutory PAs. However, this was not a ready option due to inconsistencies in counting methods between different areas and the high level of movement of game between areas (see Goss & Cumming 2013). To assess wildlife abundances and movements rigorously would have been outside the scope of this thesis and was therefore not a priority. With respect to coverage of vegetation, further details and assessments are provided in Chapter 6 where I determined the conservation of Critical Biodiversity Areas and Threatened Ecosystems as provided by PLCAs and in comparison to statutory PAs.

2.3 Results

2.3.1 Ecological Characteristics

In total, the participating 70 PLCAs conserved a land area of 253,396 ha which is equivalent to about 2% of the Western Cape Province (Figure 2). The average size of PLCAs was 3,620 ha (min: 31 ha, max: 54,382 ha).

In total, my sample of PLCAs protected 5,524 ha Albany Thicket, 5,363 ha azonal vegetation, 676 ha forest, 135,910 ha Fynbos, 42066 ha Nama-Karoo and 63,779 ha Succulent Karoo (For details see Appendix 5).

Within these broader biomes, study participants protected 11 different major habitat types as stated by owners and managers. These included aquatic habitats (such as lakes, river and bogs), coastal habitats, marine habitats, forest, Fynbos, grassland, Savanna, Karoo, mountainous habitat, Thicket and Renosterveld.

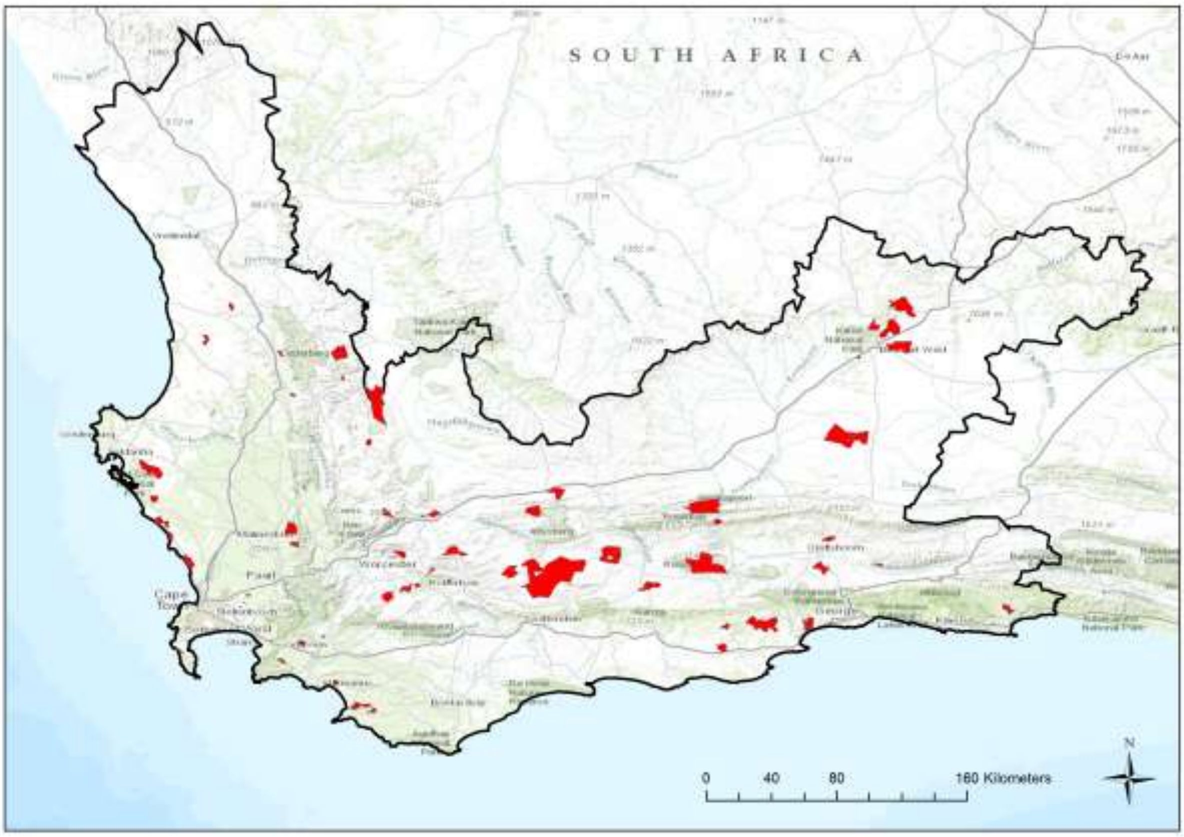


Figure 2: Extent (property sizes) of participating PLCAs in the Western Cape Province, depicted in red.

When rated on the Likert scale, more than 80% of the study participants who had Fynbos on their property rated it as their most important habitat, closely followed by Renosterveld (Figure 3). Aquatic habitats, Karoo, marine habitats, coastal habitats and mountainous habitats showed slightly lower values around 70%, whereas grassland, forest, thicket and savanna showed lowest values around 45%.

Based on biotic characteristics, PLCAs of the Western Cape Province could roughly be distinguished into two main groups: PLCAs with wildlife (40 PLCAs; large mammals such as ungulates and predators) and PLCAs focusing only on indigenous flora and fauna (30 PLCAs; species naturally occurring or endemic to the province). To most of the PLCAs with wildlife (28) the large mammals had actively been introduced and many of them are extralimital to the region. PLCAs with wildlife together kept about 32 different large mammal species with a total of approximately 14,770 individuals on their properties. The 15 most common species are depicted in Figure 4.

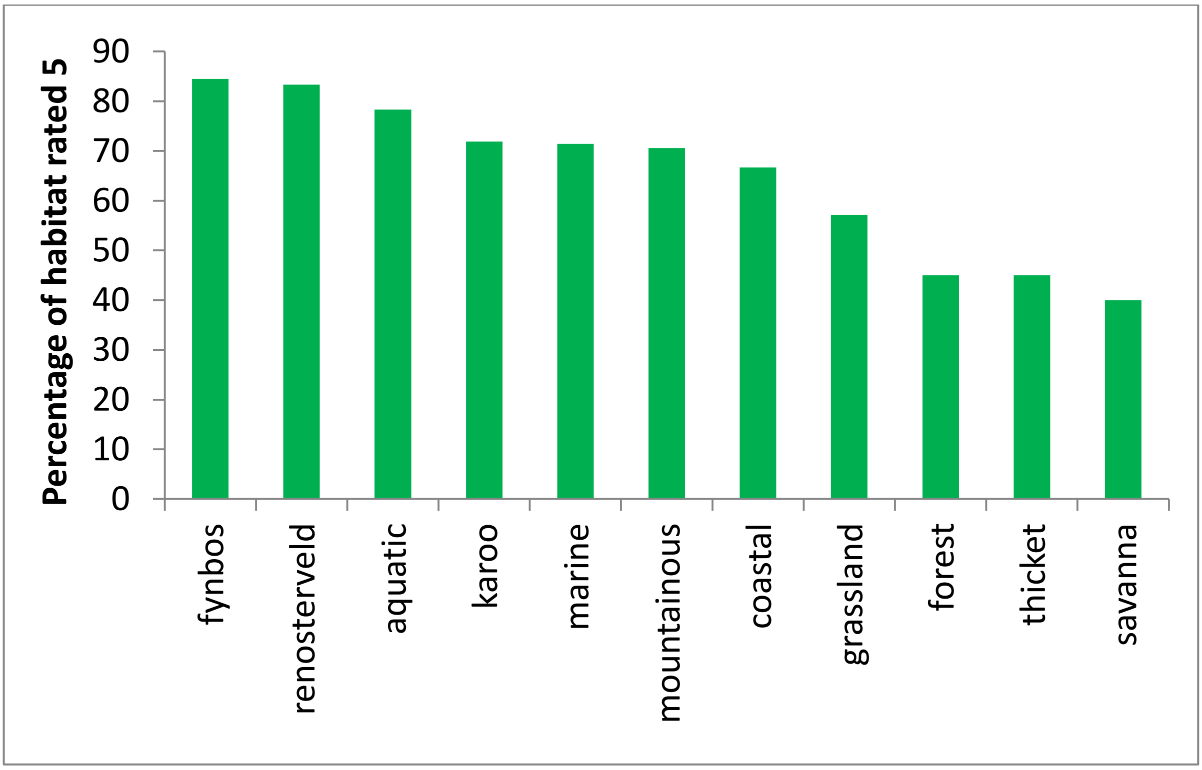


Figure 3: Importance of 11 habitat types occurring in PLCAs in the Western Cape Province. The graph shows how often habitats were rated as 5 in relation to their occurrence on the property, depicted as percentages. (Original interview question: 'How important do you consider the following habitat types to be in your park? Please rank on a scale from 1 (not relevant) to 5 (very important)'; General Questionnaire)

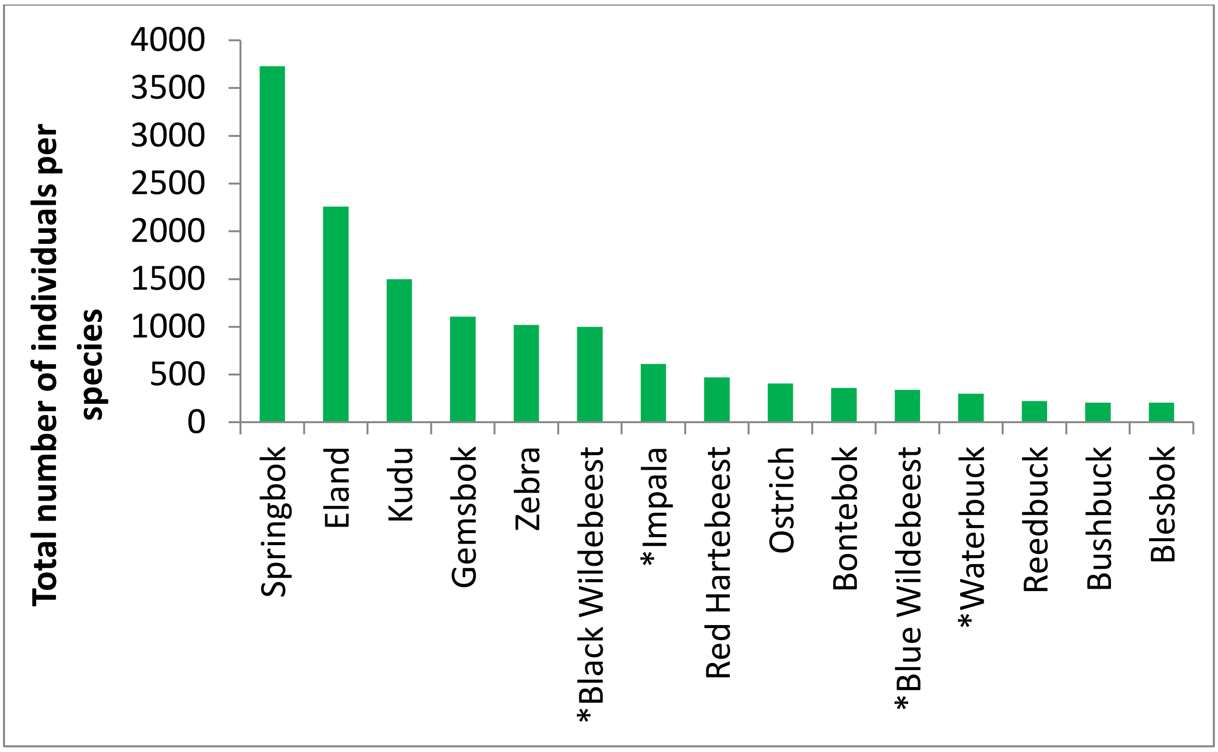


Figure 4: 15 most common large mammal species occurring in PLCAs in the Western Cape Province. Extralimital species indicated by *.

Some of the stocked wildlife species were extralimital to the Western Cape Province (e.g. impala (*Aepyceros melampus*), nyala (*Nyala angasii*), giraffe (*Giraffa camelopardalis*) which means they did not historically occur and were introduced from outside the region. Introducing these species is only permitted if two conditions are fulfilled: the PLCA has to hold a certificate of adequate enclosure and has to apply for translocation permits for each transport and trade activity. Only few large ungulate species are non-extralimital or endemic to the province, for example as Cape Mountain Zebra (*Equus zebra zebra*), eland (*Taurotragus oryx*), and bontebok (*Damaliscus pygargus pygarus*). Even these species can only be transported with translocation permits. Thirteen PLCAs also introduced species of the Big 5-group (buffalo, elephant, lion, rhino, leopard) and in total stated keeping 182 buffalo (*Syncerus caffer)*, 28 elephant (*Loxodonta africana*), 31 lion (*Panthera leo*), and 19 rhino (*Ceratotherium simum and Diceros bicornis*). None kept leopard (*Panthera pardus pardus*) enclosed on their property but 39 PLCAs stated having evidence of free roaming individuals in the area. Other charismatic species represented in PLCAs were 20 cheetah (*Acinonyx jubatus*), 109 giraffe, 1,021 zebra (Cape Mountain Zebra and Burchell's zebra (*Equus quagga*)) and 18 hippo (*Hippopotamus amphibius*).

PLCAs focusing strictly on indigenous settings (no introduced charismatic and extralimital species) mostly did not have any large mammals on their property at all and did not monitor species abundances or regulate populations. Typical species occurring in these PLCAs were smaller mammals, reptiles and predators such as Common Duiker (*Sylvicapra grimmia)*, Cape Grysbok (*Raphicerus melanotis*), Caracal (*Caracal caracal***)**, Black-backed Jackal (*Canis mesomelas*), Cape Porcupine (*Hystrix africaeaustralis*), Honey Badger (*Mellivora capensis)*, Cape Baboon (*Papio ursinus)*, tortoises, snakes, and many bird species. Some PLCAs identified between 150 and 250 bird species and kept accurate lists. Generally, conservation on private land plays an important role for the protection of many endangered species in the province. Well-known examples are Cape Leopard, Cape Mountain Zebra, Geometric Tortoise (*Psammobates geometricus*), and the Knysna Loerie (*Tauraco corythaix*).

During interviews it became apparent that PLCAs in the Western Cape Province faced many management problems. A fundamental issue was poaching which refers to killing or illegal extraction of both animal and plant species from properties, such as antelopes, reptiles, rhino or proteas. Twenty-nine PLCAs of my sample were challenged by poaching activities impacting wildlife on their properties, however had no records to assess the scale and intensity of the impact. Intensive management was also required in many cases with respect to other environmental problems. Thirty-one study participants had to deal with soil erosion as the most frequent issue for management. Soil erosion often stems from former land use of the properties (i.e. traditional farming) and some interviewees, who formerly used their properties for traditional farming themselves and subsequently changed land use into a reserve, stated that soil erosion already then was an issue. Some PLCAs also experienced too frequent wildfires (4 participants) or other problems such as pollution residing from former land-uses (5 participants). Also, free roaming predators occurring in surrounding areas or on the property itself were named, mainly black-backed jackals (*Canis mesomelas*, Schreber 1775) and caracals (*Caracal caracal*, Schreber 1776), and leopard as mentioned above. Their presence poses management challenges to landowners and managers if wildlife within fences is at risk. Sixty-three study participants named at least one predator species to occur in proximity. Eighteen study participants actively manage predators mostly by means of monitoring, collaring and better fencing but even lethal methods were mentioned.

Another major impact was caused by invasive species, which influence local flora and fauna (Table 1). In some PLCAs, invasive species had to be managed intensively to reduce negative effects. Mainly plant species had to be dealt with which replaced indigenous vegetation or reduced available water resources. Only 13 PLCAs of my sample stated not having invasive plant species on their properties. In the remaining PLCAs, an average of two invasive plant species was present with a minimum of one and a maximum of eight species. Most common species were *Acacia saligna (Labill.) H.L.Wendl.* (Port Jackson), *Eucalyptus saligna Sm.* (Blue Gum) and *Acacia mearnsii De Wild.* (Black Wattle). These were followed by seven other frequently stated species or species groups. In addition to these ten typically occurring species, 29 more species were also mentioned to be present in individual PLCAs ("other" in Table 1).

Table 1: Invasive species found in PLCAs in the Western Cape Province (stated species were most common and known to PLCA owners/managers)

Species	habitat reserves	game reserves	total PLCAs
Acacia saligna	11	8	19
Eucalyptus saligna	11	7	18
Acacia mearnsii	6	10	16
Pinus spp.	13	0	13
Acacia cyclops	5	5	10
Acacia spp.	9	1	10
Hakea spp.	6	2	8
Opuntia spp.	3	5	8
Atriplex spp.	1	3	4
Arundo donax	1	2	3
number of other species	29	15	44

Despite management often being intensive, future expansion of the property would be a potential option for 47 PLCAs. Reasons for such an expansion, which are not directly related to current management objectives or original reasons for establishment of PLCAs, represented a mix of socio-economic and ecological factors. Figure 5 depicts the factors which were rated as most important (as 5 on the Likert scale from 1 (not relevant) to 5 (very important)). The foremost factor was the objective of taking action in conservation, which was rated highest by 35 study participants. The second most important reason was expansion being a personal aim, followed by spatial connectivity to other protected areas as the third most relevant reason. Further factors for choosing a site for PLCA expansion would be land prices as constraint, rare ecosystems being present, and species richness. Interestingly at first glance, income increase was not rated as very important by many study participants. However, many stated that often a property expansion is rather linked to additional costs (such as increased need for management action, fencing, infrastructure, land purchase etc.) relative to the potential for making profit.

Management of a protected area is influenced by the context in which it occurs. This context relates to both ecological and socio-economic conditions, such as habitat types or legislation. Landowners and managers of PLCAs in the Western Cape Province rated both ecological and socio-economic conditions as very influential on their PLCAs (Figure 6). The two most important factors were ecological, namely habitats and species composition. The third was socio-economic, namely infrastructure inside and outside of PLCAs. Generally, more ecological factors were considered relevant for management than socio-economic factors such as collaboration or proximity to other protected areas.

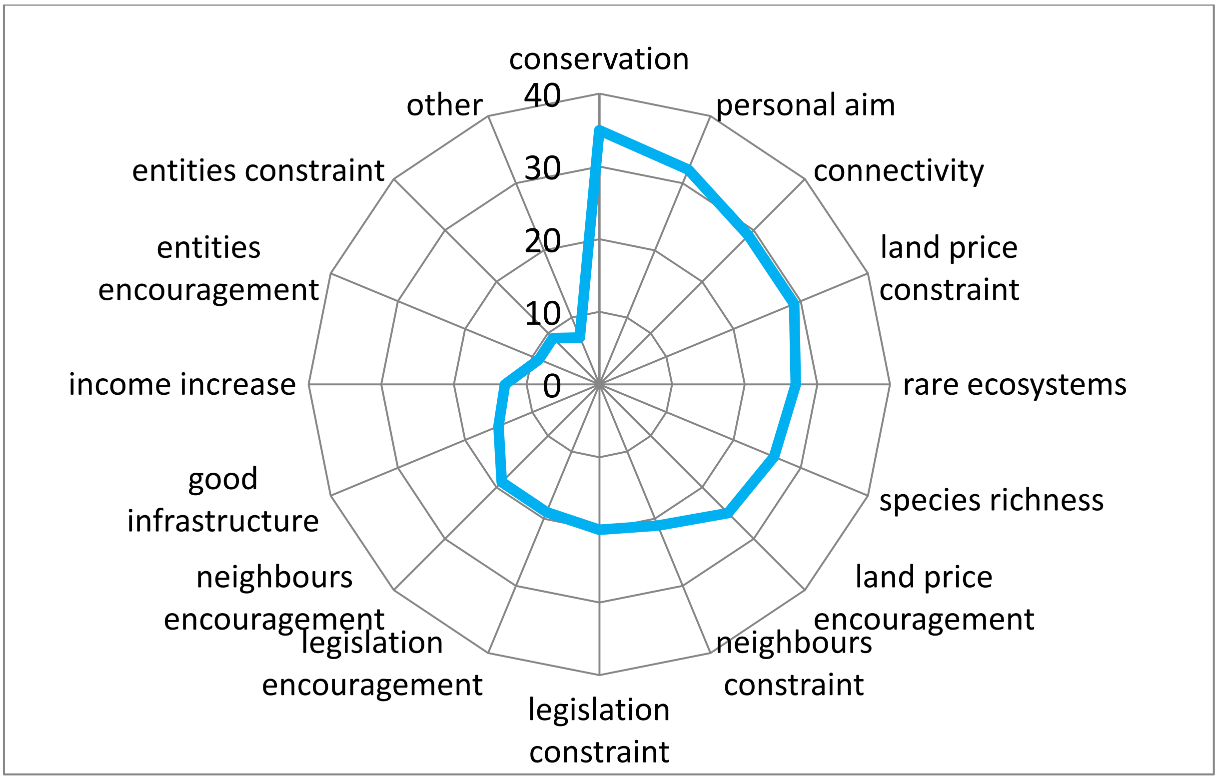


Figure 5: Most important factors determining potential property expansion of PLCAs, rated as 5 on a scale from 1 (not relevant) to 5 (very important) by landowners and managers. (Original interview question: 'What would affect your decision to expand the park most? Please rank on a scale from 1 (not relevant) to 5 (very important)'; General Questionnaire)

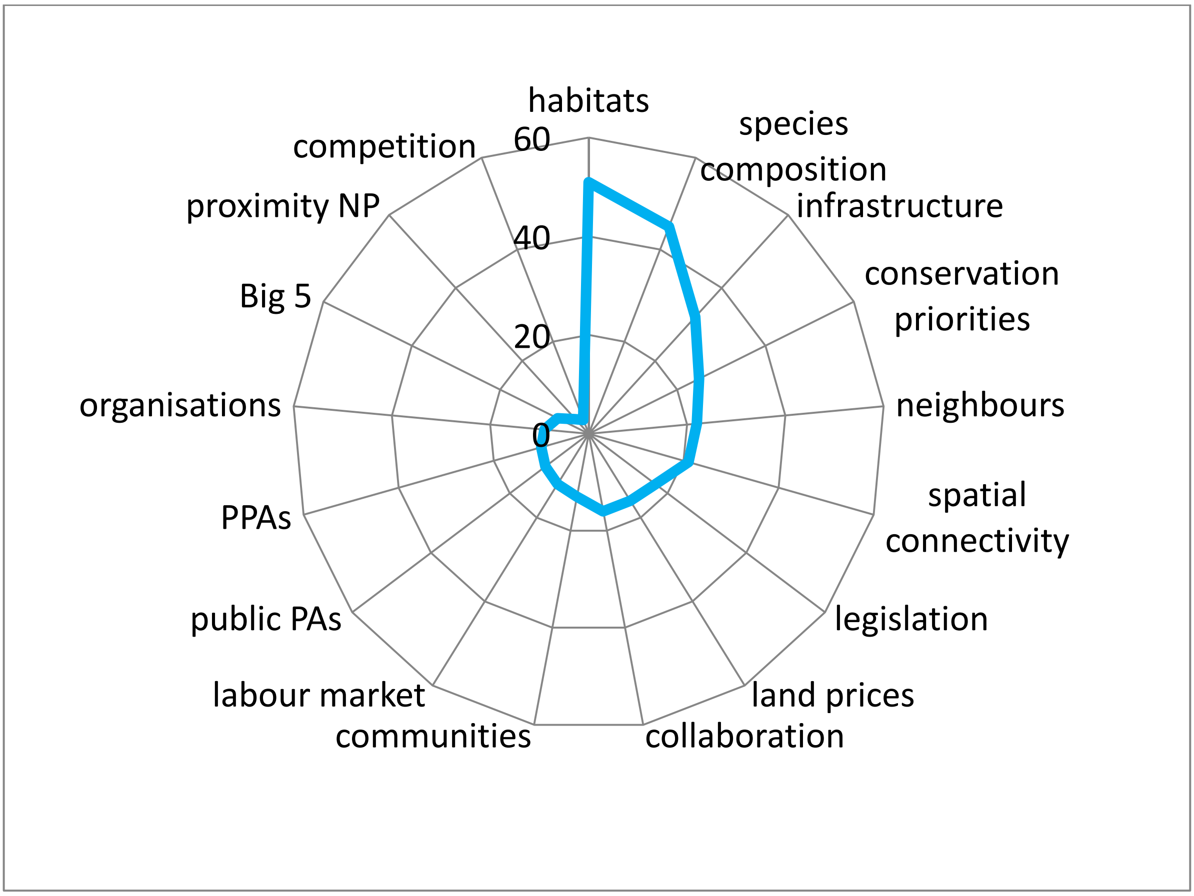


Figure 6: Most important factors which may determine PLCA management, rated as 5 on a scale from 1 (not relevant) to 5 (very important) by landowners and managers. (Original interview question: 'How important are the following conditions for the maintenance/ running/ tourism of a private protected area? Please rank on a scale from 1 (not relevant) to 5 (very important)'; General Questionnaire)

2.3.2 Socio-economic Characteristics

PLCAs in the Western Cape Province were on average 17.5 years old. The oldest PLCA among the study participants was 45 years of age and the youngest was 2 years of age. This means that the majority of PLCAs in the Western Cape Province represents relatively recent conservation action.

The majority of PLCAs in the Western Cape Province were formerly agricultural areas (Figure 7). Cattle ranching was the most frequently stated former land-use, followed by farming crops. The category 'other' incorporated a range of activities, for example flower harvesting, grazing, or recreational use as holiday retreat.

Reasons for engaging in PLC differed strongly among individual landowners and managers. Most frequently, taking action in conservation was stated being the most relevant objective (Figure 8). Second most relevant was developing a business, however, fewer study participants rated it as being highly relevant when compared to conservation action. Further, to some study participants their PLCA was a family home which should be preserved, whereas education and research were less important reasons for establishment. 'Other' objectives in some cases were for example to have a personal holiday retreat or love for nature.

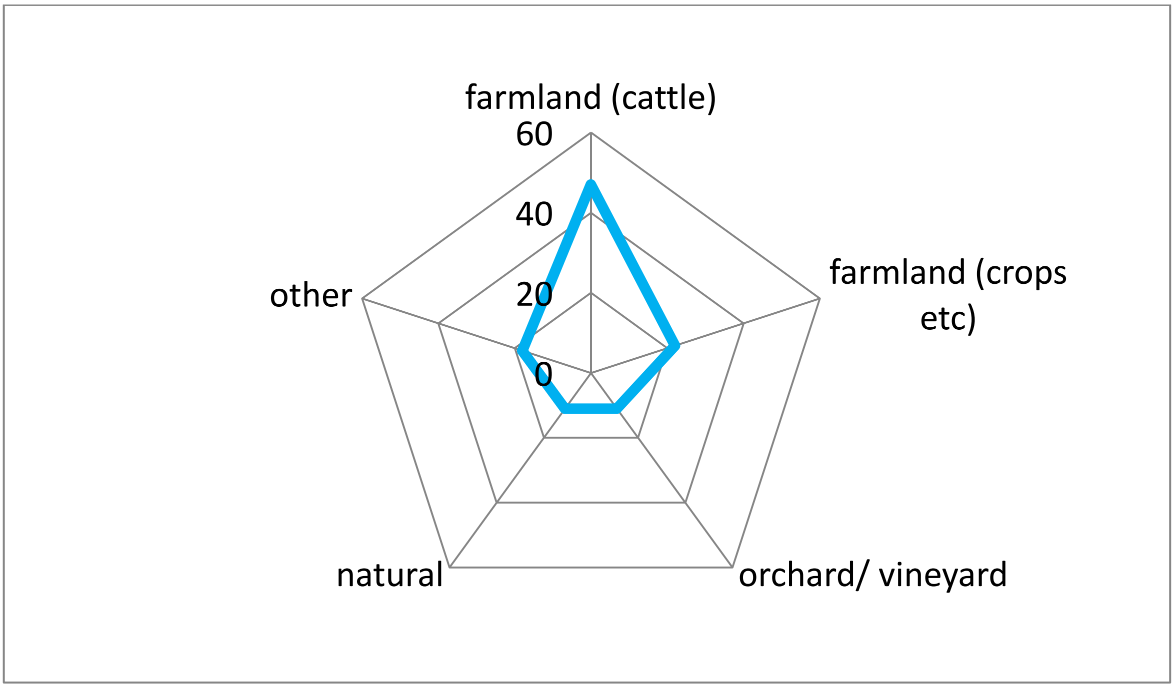


Figure 7: Former land-use types of PLCAs in the Western Cape Province, depicted in order of importance. 'Other' incorporates a range of activities, e.g. flower harvesting, grazing or recreational use as holiday retreat

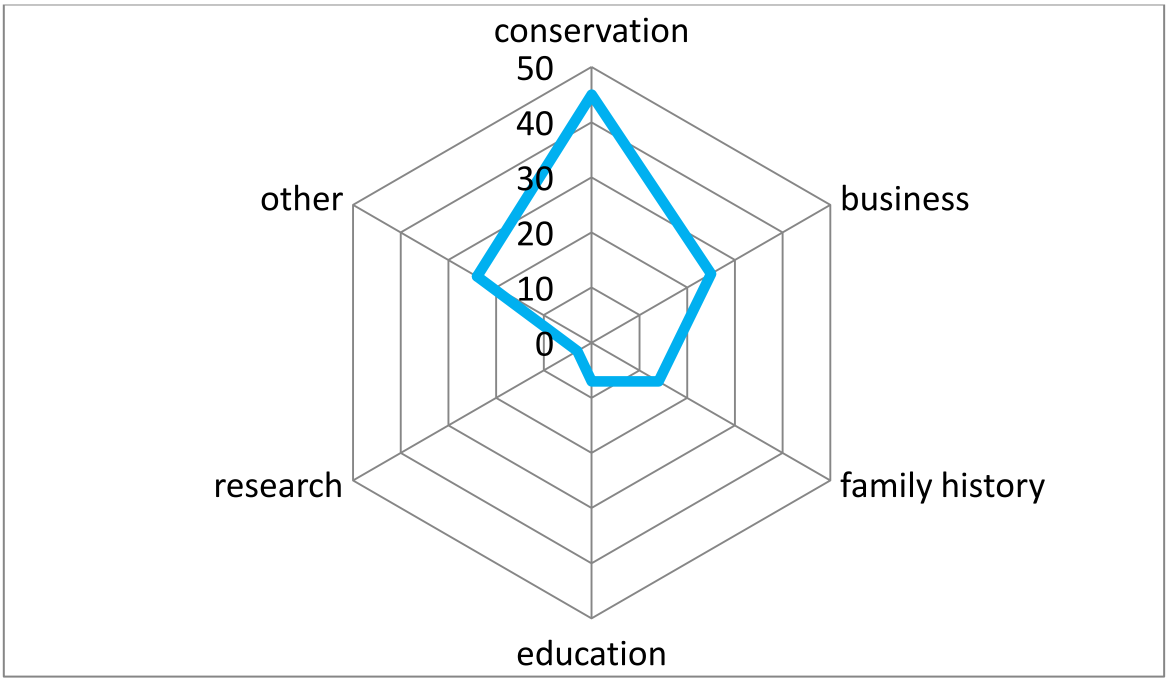


Figure 8: Most important reasons determining the engagement in PLC in the Western Cape Province; rated as 5 on a scale from 1 (not relevant) to 5 (very important) by landowners and managers. (Original interview question: 'Due to which purpose was the area originally established? Please rank on a scale from 1 (not relevant) to 5 (very important)'; General Questionnaire)

PLCAs are currently utilised by different types of area users. These may be tourists, researchers or people living in the surrounding landscape. The participating 70 PLCAs welcomed about 357,700 visitors annually in total (min: 30; Max: 60,000). 19 PLCAs had a clientele that consisted of more than 50% international guests. Day visitors and overnight visitors could not be distinguished and occupancy not assessed since many PLCAs were not keeping detailed records. Game reserves showed higher visitation rates than habitat reserves (Figure 9).

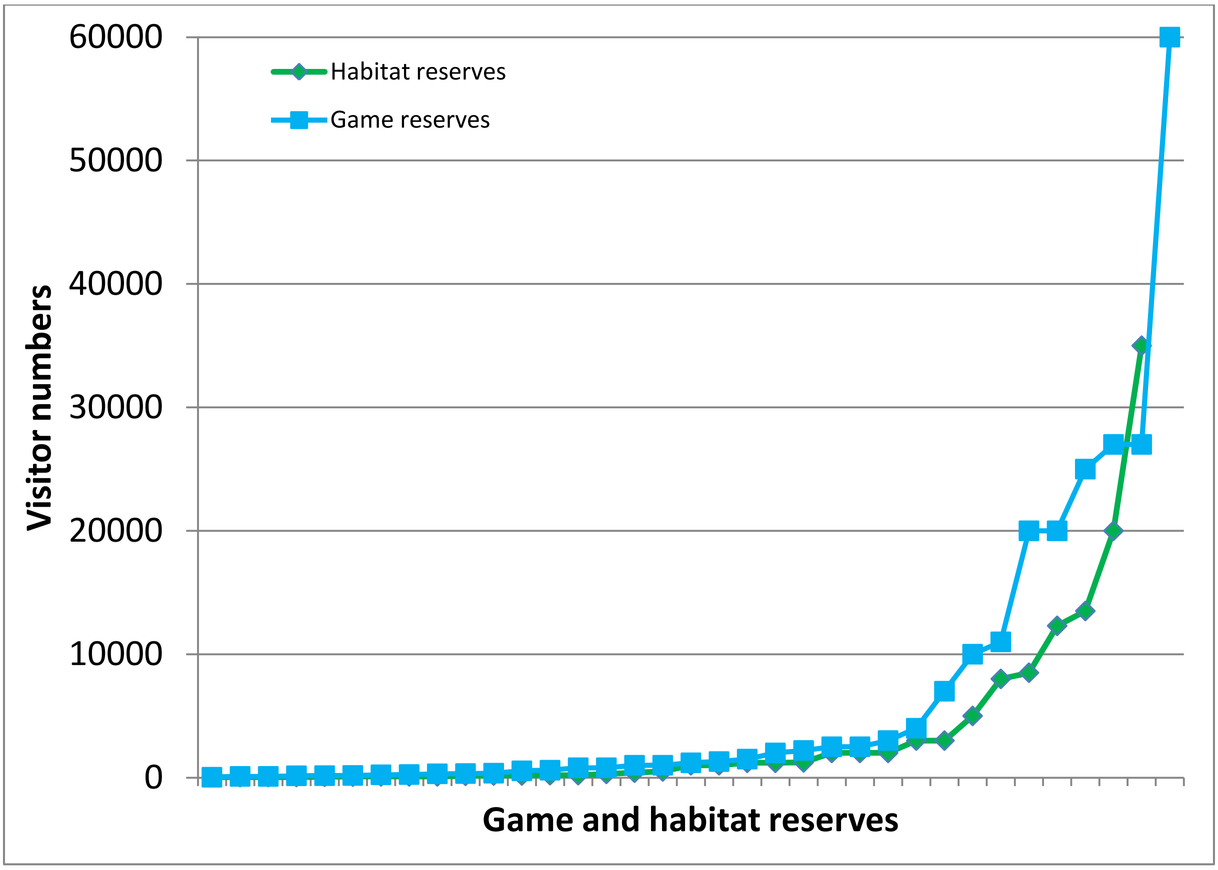


Figure 9: Distribution of annual average visitor numbers in PLCAs in the Western Cape Province; distinguishing game and habitat reserves.

An important feature relating to tourism is the provision of different facility and activity types in PLCAs. In total, PLCAs in the Western Cape Province offered 18 different types of activities and facilities on their properties (Figure 10). On average, guests could make use of 8 different facility and activity types (min: 1, max: 13).

Providing ecotourism experiences can in many cases only be achieved by employing staff. PLCAs differed strongly in number of staff members. In total, the 70 participants employed 1,215 staff members (min: 0, max: 130) with an average of 17 employees. Seven PLCAs had no staff members at all. When determining whether or not staff members originate from or live in an area within 50 km proximity to the PLCA, five PLCAs responded that this applied to none or less than half of their employees. The majority of study participants (83%) employed more than 50 % or all their staff from surrounding areas.

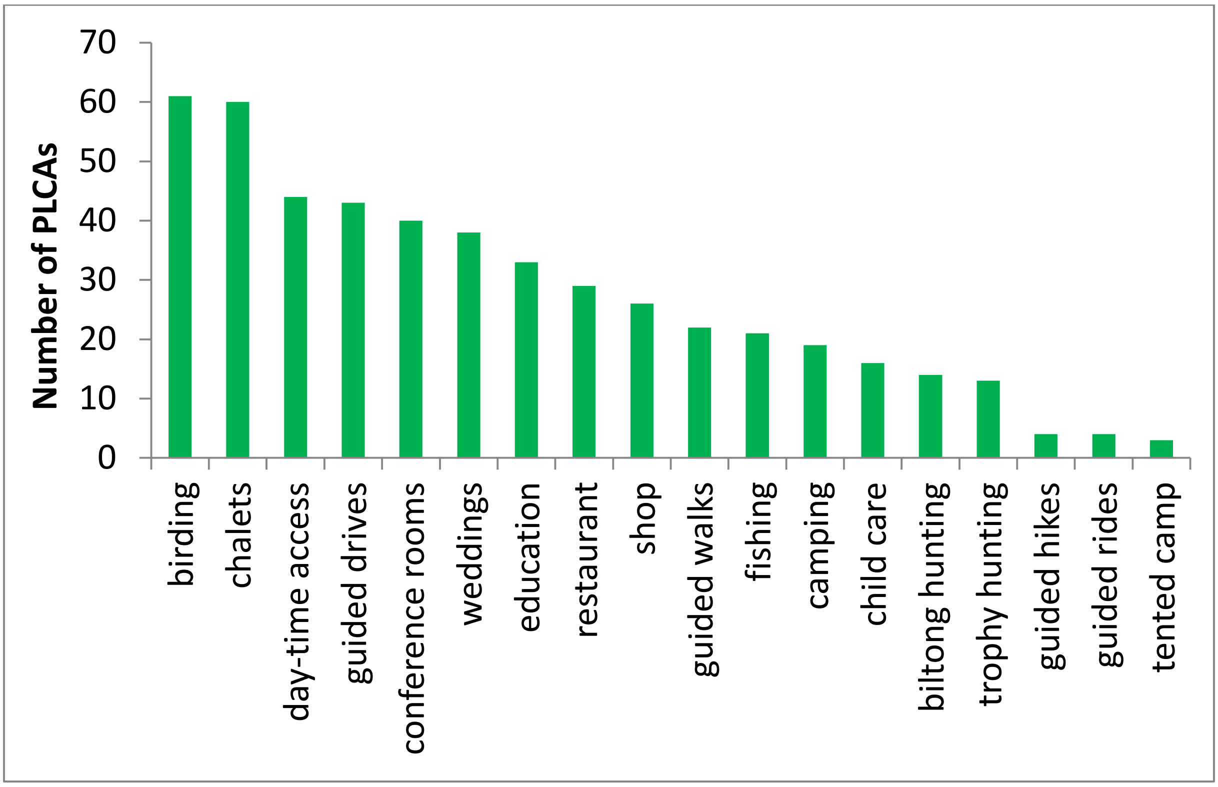


Figure 10: 18 different facilities and activities in PLCAs in the Western Cape Province

PLCAs in the Western Cape Province represented very different economic settings and could be roughly split into two groups, self-sufficient or not. Being self-sufficient means the PLCA itself could be maintained by income generated from activities on the property (such as game drives, accommodation or hunting). Not being self-sufficient means that other external income was used to pay PLCA expenses. These other income types could be derived for example from farming or another profession of the owner. Only 48 out of 70 participants (69%) were self-sufficient; the rest relied on external funds.

37 of the 70 participants provided financial information. 15 different income sources (Figure 11) contributed to the total income of these 37 study participants (min: 1, max: 11; mean: 3.5). Eight PLCAs also stated having ‘other’ income types (such as membership fees or honey production) which are not depicted in the figure but included in the calculation.

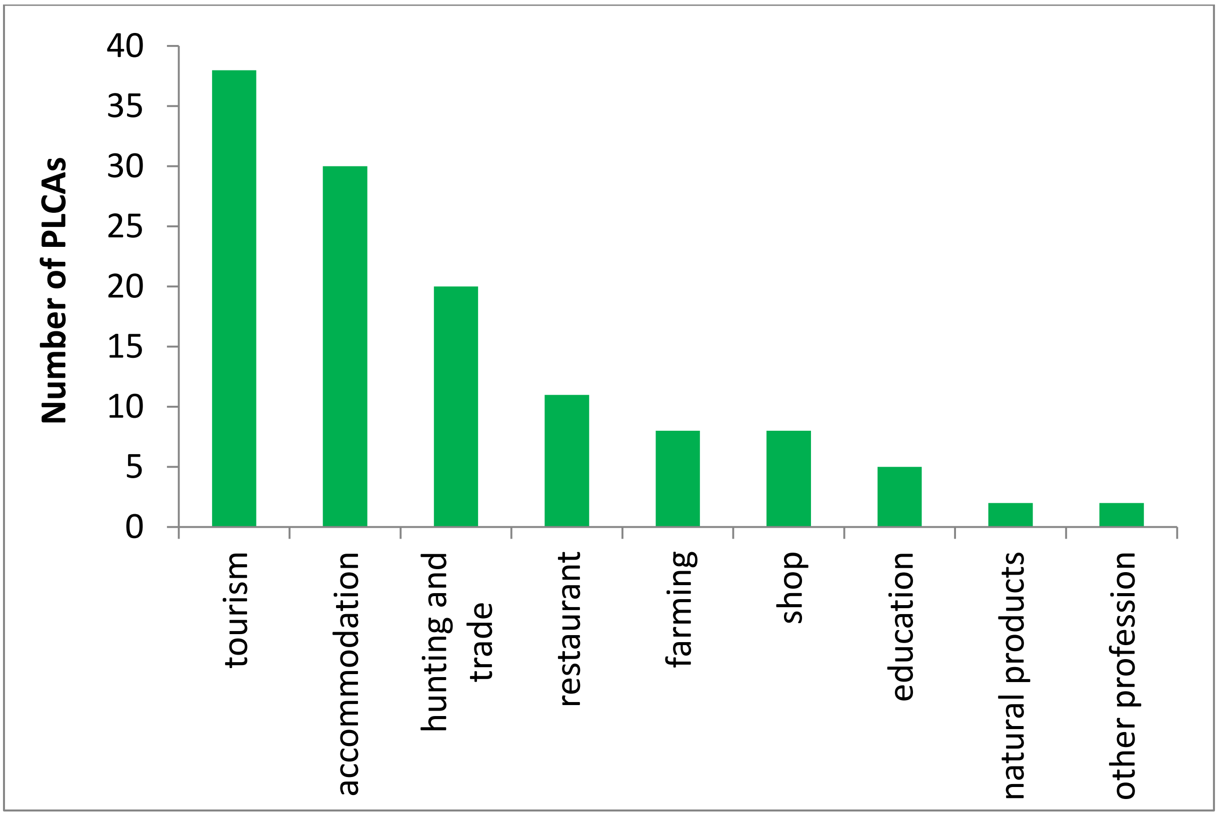


Figure 11: Income types of 37 PLCAs in the Western Cape Province

A similar dynamic pattern was represented by the expense situation of PLC. Generally, PLCAs in the Western Cape Province had to handle 11 different types of expenses (min: 1, max: 7, mean 4.5) (Figure 12). Six participants also stated having 'other' expense types (such as clearing alien vegetation or paying off a bond) which are not depicted in the figure but included in the calculation.

An opportunity to creating financial viability or at least supporting PLC can be a payment scheme for provision of ecosystem services (PES). Although some study participants were strictly against any involvement of other stakeholders on their properties, 40 study participants were interested and open to an implementation of such a PES (e.g. financial support for invasive species clearing).

Conservation emerged as the single most important future objective for management in PLC in the Western Cape Province (Figure 13). The second strongest objective was to develop reserves for tourism, followed by providing ecosystem services (ES) to society. As in the rating of reasons for establishment, running a business was stated as being relevant by much fewer study participants and rated fourth. Preserving PLCAs as private properties, heritage sites or family homes was also important to some study participants. Generally, the most relevant future objectives represented a spectrum of both ecological and socio-economic objectives.

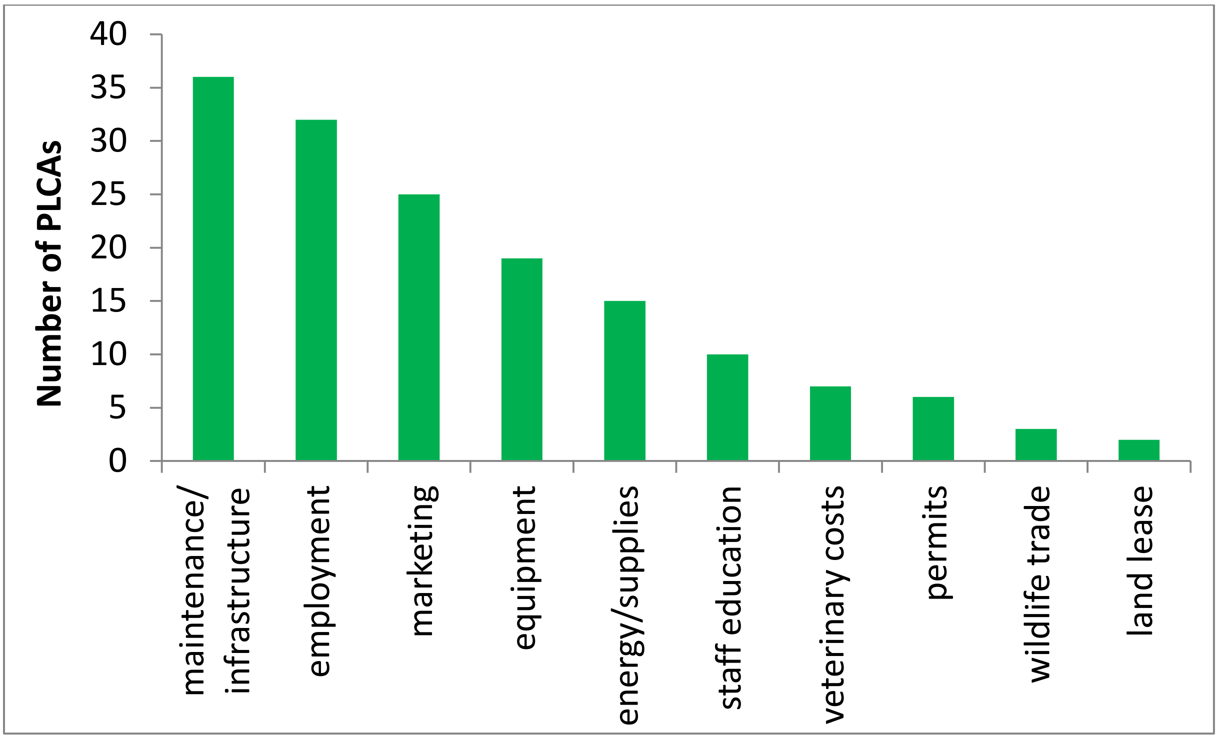


Figure 12: Expense types of PLCAs in the Western Cape Province

Challenges which might have to be tackled by PLC are strongly related to future management objectives. When asked about conditions potentially putting PLCAs at risk of failure, the impacts of economic factors (such as rising energy costs or a crisis in international tourism) were rated as most influential (Figure 14). These mainly represent slow variables which cause uncertainty and are difficult to control. Social factors were perceived as second most important while ecological factors were the least relevant. Landowners and managers of PLCAs stated that ecological challenges were the easiest to deal with in comparison to social or even economic factors such as recession or changes in labour market conditions.

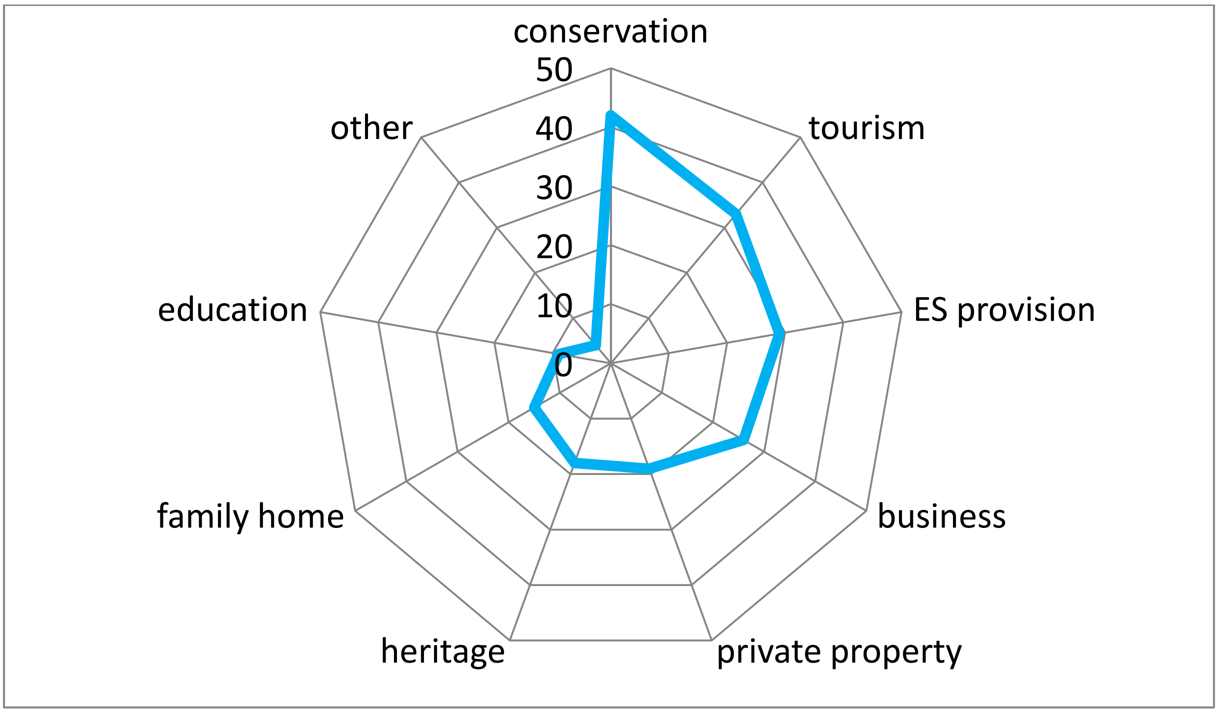


Figure 13: Most important objectives for future management in PLCAs in the Western Cape Province; rated as 5 on a scale from 1 (not relevant) to 5 (very important) by landowners and managers. (Original interview question: 'How do you perceive your park regarding the following purposes? Please rank on a scale from 1 (not relevant) to 5 (very important)'; General Questionnaire)

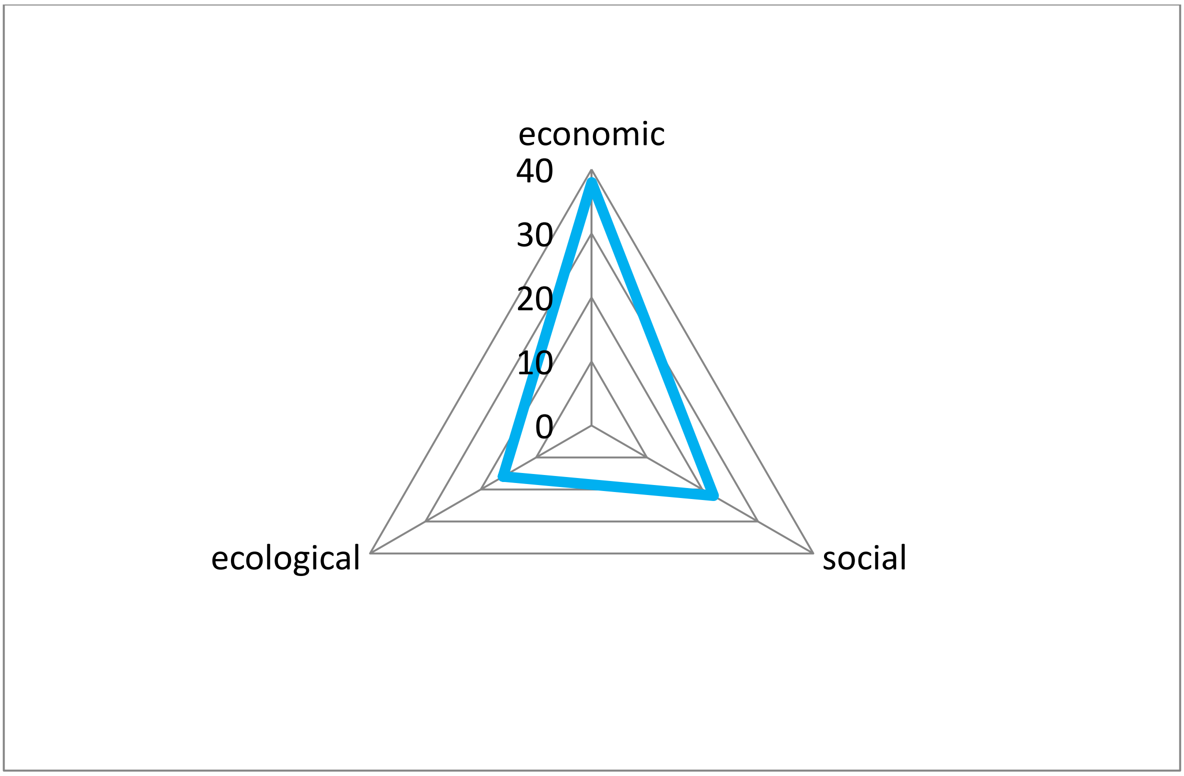


Figure 14: Most important reasons for potential future failure in PLCAs in the Western Cape Province; rated as 5 on a scale from 1 (not relevant) to 5 (very important) by landowners and managers. Economic risks represent e.g. fluctuations in international tourism; social risks are e.g. regional crime. (Original interview question: 'Which reason is in your opinion the main risk of general failure in a nature reserve? Please rank on a scale from 1 (not relevant) to 5 (very important)'; General Questionnaire)

2.4 Discussion

Identity components of PLCAs in the Western Cape Province differed immensely between individual settings and represented a wide range of corporate models. On the extremes and very distinctly, some PLCAs catered for high-end low-volume ecotourism and others for low-end high-volume ecotourism. High-end, low-volume ecotourism in PLCAs is a significant industry in southern Africa targeting international visitors from high income countries (Magole & Magole 2011), however, a domestic market is also supported which creates a demand for low-end ecotourism (Bond et al. 2004).

Visitation rates in PLCAs across the Western Cape Province varied strongly together with the management strategies and objectives, such as whether or not to introduce charismatic species or to engage in hunting, wildlife trade or other wildlife-based utilization. Further striking differences occurred with respect to protected habitat types, species composition, employment, activities and facilities provided, age, property sizes, income sources and economic viability. Some of the striking similarities across the sample were that most PLCAs had been established on former agricultural land and common management issues were poaching and invasive species. Nevertheless, property expansion was an option to the majority of study participants, and strongest motivation or objectives for establishment and future management of PLCAs was conservation, closely followed by operating a business.

My findings confirmed that PLCAs in the Western Cape Province showed similar characteristics and faced similar opportunities and challenges as PLCAs in other countries and contexts. For example, a third of my study participants were not self-sufficient and had to rely on external income sources, such as having another profession or using their pension to fund the PLCA. Many therefore would be interested in incentive programmes to support their existence and conservation action as opposed to the implementation of command and control mechanisms (e.g. through payments for invasive plant clearing or reforestation with native tree species). In the USA, various incentive mechanisms are already put in place and research findings recommend to increase their utilisation in order to increase PLC (Paulich 2010). Furthermore, common concerns among study participants were raised that mainly economic factors may put PLC at risk for failure in the future. Most interviewees stated that they feel that social and especially ecological disturbances (such as regional crime, political instabilities, disease outbreaks or wildfire which mostly refer to fast variables) would be possible to handle whereas economic disturbances would be out of direct control (such as fluctuations in international tourism or economic recession which all refer to slow variables). This is of concern, since conservation biology continues to focus on ecological disturbances instead of addressing the dynamics of socio-economic risks. Langholz (1996), who conducted one of the first comprehensive comparative investigations of PLCAs across Sub-Saharan Africa and Latin America, also provided insight into the economic situation, objectives for operation and factors influencing management of PLCAs. At that time, also about half of the assessed PLCAs were not profitable. Important objectives also represented foremost actions and aims related to conservation, followed by more economic objectives. Factors determining the achievement of objectives related to ecological features occurring on the properties, followed by more socio-economic factors. When compared to my findings, these trends and characteristics of PLC have not changed substantially.

PLC is a dynamic and complex phenomenon. It is influenced by slow and fast variables which cause uncertainties and can often not be controlled directly. Landowners and managers are facing tasks which are in many cases characterized by having to deal with trade-offs.

A distinct example of trade-offs caused by interrelated system characteristics is the stocking of charismatic species. With respect to opportunities, they potentially attract more visitors in ecotourism and can thus contribute to the economic viability of a PLCA (Lindsey et al. 2007). Beyond individual PLCAs, ecotourism on private land can contribute to ecotourism success on regional and national levels when statutory PAs cannot provide enough resources like in Nicaragua (Barany et al. 2001). Income derived from ecotourism and conservation action on private land may support the protection of endangered species, such as rhino in Zimbabwe (De Alessi 2000; Lindsey et al. 2005). Contrarily, many charismatic species are regarded as extralimital to the Western Cape Province and perceived with ambiguity and criticism by conservation organisations or scientists, for example in relation to overgrazing of local habitats. Their attraction value in ecotourism was questioned and stocking large mammals may cause conflicts such as poaching (Maciejewski & Kerley 2014b). Large mammal species can cause high costs for management, e.g. high value species such as rhino need anti-poaching activities on site (with trained staff or involving external specialists). One study participant stated to pay a monthly insurance premium on his rhinos, in case of them being killed, to not lose major capital. Generally, especially Big 5 species are introduced to PLCAs based on the influence of visitors (or the assumption that visitors are attracted by them), which may twist locally meaningful conservation into benefit-driven management decisions.

Closely related to the stocking of charismatic species generally is the introduction specifically of extralimital species which did historically not occur in the Western Cape Province (such as Impala). Among PLCA owners and managers there are discussions taking place as to whether or not this concept is meaningful. Some question how a historical date can be significant in determining the contemporary influence and suitability of certain species in a certain region. Despite the awareness of potential negative impacts on indigenous flora and fauna, the argument is raised whether it would not be more adequate to assess the actual impact of certain species in detail and in relation to the carrying capacities of the region or PLCA in question. To individual PLCAs, some extralimital species provide high economic values (whether through ecotourism or wildlife breeding, trade and hunting such as Golden Wildebeest) and landowners and managers feel restricted in their business opportunities by current legislation.

Another situation causing trade-offs is the general implementation or expansion of PLCAs itself. Depending on the motivation, behaviour and attitudes of owners and managers for establishment and operation, the focus of PLC might differ substantially (Mir & Dick 2012). Motivations and objectives range from providing societal benefits (e.g. conservation), via self-directed benefits (e.g. privacy or financial profit), to personal and family-related benefits (e.g. bequest value of a property or love for nature) (Langholz 2010; Stolton et al. 2014). My data confirmed this, where study participants rated conservation objectives as most important reason for establishment, followed by business objectives. For example, one study participant mentioned an interesting concept as to providing a landscape likely being an oxygen source to society. Responses, when critically engaged with, could be perceived as potentially influenced by responder bias towards the study purpose and the researcher conducting the interviews. For example, emphasis could be placed on conservation as stated main objective rather than business because the interviewer holds a corresponding academic background and the study participant seeks to appeal towards the study goal. However, according to personal experiences, landowners and managers of my sample occurred being exceptionally open and truthful in their responses and were not shy to also state contradictory or counterintuitive opinions.

Property sizes of PLCAs also depended on different factors such as the history of the property and current contextual conditions. Historically a property was either inherited, purchased or split off from a larger property and was either originally utilized under different land use and transformed or directly implemented as conservation area. Current conditions determined whether or not a property could be expanded. This relates to conservation opportunity meaning whether or not land in proximity is available, economically affordable to the landowner or motivation of landowners leads to the implementation for property expansion (Knight et al. 2011; Raymond & Brown 2011). One interviewee stated the strong wish to increase his property area no matter the costs, however, there was no land available from none of the adjacent properties which were mostly under state management or farmland which the corresponding owner did not want to sell and have transformed into a conservation area. Others stated that they would immediately expand their properties if they had the financial means to do so and that high land prices were a dominant constraint.

In relation to property sizes, also the fact that the majority of PLCAs was under agriculture as former land use directly links to the driving factors of PLC (such as loss of subsidies, increasing profit potential from hunting or ecotourism) representing the historical context of Southern Africa which led to the shift towards wildlife-based utilization of private lands (see section 1.6, Chapter 1). Nonetheless, reasons for engaging in PLC as stated by study participants ranged from intrinsic values (such as 'love for nature' and 'family history') to business related purposes ('main source of income').

The huge span of PLCA ages confirmed that PLC is a dynamic industry. Every year, new PLCAs are established, there is a constant expansion of PLC in the Western Cape Province. These dynamics are both based on conservation efforts and ethics as well as contextual influences (such as transition from agricultural practices to wildlife utilization) which date back more than four decades (see section 1.6, Chapter 1). To my knowledge, of the approximately 130 potential study participants which I had identified (as described in section 1.9, Chapter 1) only five changed the purpose and land use of their properties away from conservation and wildlife-based utilization during the duration of my research project.

The habitat importance rating provided by PLCA owners and managers showed that study participants highly value the habitats which are occurring on their properties, especially the habitat types which are either highly sensitive, under threat or not typically present (such as renosterveld and marine environments). These ratings were mostly based on informed opinions and specialist knowledge, but also influenced by personal preferences as well as the influence from visiting tourists and thus profit making. It is known that visitors value different features of PLCAs and make use of different facilities and activities, according to their demographics such as education, age and origin (Hearne & Salinas 2002; Spenceley et al. 2015). For example, one landowner stated that he chose his property with the awareness that a stream was present which he could use to attract visitors with for recreational potential.

Future management objectives on PLCAs were primarily focused on conservation, however, were closely followed by objectives to develop reserves for tourism. The actual orientation of an individual PLCA thereby highly depends on the preferences of the owner. Opinions differed widely as to whether or not ecological features of the properties are to be valued by intrinsic measures or to be viewed as assets to utilize. One interviewee responded: "We run a business, and conservation is the valuable by-product".

Another trade-off in PLC is caused by free-roaming predators such as leopard, caracal or jackals to be present in proximity or on the properties in relation to the use-value of ecological features, mainly stocked animals. Predators cause a risk for landowners with high-value antelope species (e.g. black springbok), however, are no harm to other PLCAs where the set-up is less focused on such species. A decision has to be made on whether or not and how to manage wild predators or in contrary sacrifice game within fences. One interviewee stated that he highly values having a leopard in proximity and therefore is willing to lose several antelopes a month. He already had calculated the regular loss of capital and defined it as operating cost of the business. Similarly, invasive plant species may be of value to PLCAs for example in providing fire wood or animal fodder without additional expenses.

In employment, most study participants made a large contribution to local upliftment by employing more than 50% or all of their staff members from surrounding communities and areas. Many PLCAs also provided training or engaged in local education and research activities. Additionally, some allowed the utilization of their properties for other purposes such as bee keeping, reed cutting or medicinal plant extraction. To my knowledge, no property was, however, involved in legally implemented community-based conservation and no land claims had been lodged concerning properties of my study participants.
PLCAs in the Western Cape Province are in their identity not only restricted by battling with challenges. Many conditions, sources of continuity and sources of innovation allow for huge opportunities in PLC. A striking example is that of Grootbos Nature Reserve (Privett et al. 2002). The tourism initiative developed conservation commitment, involvement of local communities and sound environmental practices by investing large amounts of capital. These mechanisms resulted in additional benefits such as employment, higher visitation to the region, increased environmental awareness and business opportunities in the area.

In combination, my findings highlight that private conservation is a social-ecological phenomenon. Many internal and external system characteristics were interrelated and simultaneously represented either opportunities or challenges to different stakeholders. Trade-offs caused by influences across scales became apparent, and these have to be understood and accounted for in future decisions regarding implementation and management of PLCAs.

In light of the vital role which PLC may play for conservation and society, particularly in South Africa, questions about identity, viability and conservation contribution have to be addressed at a local scale. As a fundamental finding of my study highlighted so far, PLCAs in the Western Cape Province differed substantially among each other due to a unique characteristic (i.e. whether or not they stocked charismatic species). Alongside PLCAs which stocked large mammals and hosted safari-type ecotourism, many PLCAs without large mammals but focusing on indigenous settings exist. It thus appeared possible that these PLCAs may substantially differ in several other characteristics as well, leading me to test whether several clearly distinct types of PLCAs might exist for the province. Characterising these types would provide a useful aid to generalisation from individual cases with respect to PLCA management, conservation planning and building desired resilience in the entire conservation system. Options for building such resilience can be achieved by maintaining diversity and redundancy, e.g. several PLCAs of the same type, and by managing slow variables and feedback, which possibly are very similar for potential distinct PLCA types (Biggs et al. 2015).

Since PLCAs as SESs are embedded in and influenced by local contexts, it further seemed important to investigate whether the spatial location of PLCAs determines their identity. Along this line, Langholz & Lassoie (2001) and Kreuter et al. (2010) identified several pressing questions for future research on private and community-based nature conservation in South Africa. An important research focus should lie on understanding the external social, political, institutional, and physical environments and conditions which influence PLCAs and their sustainability. In the same way, although speaking about PAs in general, Laurance et al. (2012) stated that environmental conditions outside PA boundaries are nearly as important as changes and influences inside. This is due to the fact that PAs relied on the surrounding ecological processes, species composition and recreational capacity to remain in a healthy state.

Chapter 3: Geographical Location influences the Identity of Private Land Conservation Areas

3.1 Introduction

A growing amount of research globally assesses Private Land Conservation (PLC). So far, most assessments, however, have considered single or a few characteristics of Private Land Conservation Areas (PLCAs) such as their ecological settings, social issues or political context and not addressed the phenomenon holistically (Logan & Wekerle 2008; Snijders 2012; Iftekhar et al. 2014). Pauchard & Villarroel (2002), for example, investigated the role of PLCAs in ecotourism, and Sims-Castley et al. (2005) discussed their potential contribution to poverty alleviation. A more comprehensive approach was provided by Fitzsimons & Wescott (2004) in which greater emphasis is put on both the management or tenure of the conservation land (e.g. private ownership) and the protection mechanism (binding and non-binding agreements). The authors argue that the often internationally applied IUCN category principles on protected areas need to be expanded in order to represent the variety of conservation lands across landscapes.

A main constraint relating to PLC is that numerous different definitions of PLCAs exist, and terminology relating to PLC is not applied uniformly which makes comparison of assessments difficult (Carter et al. 2008; Stolton et al. 2014). Furthermore, the diversity of both research topics and definitions of PLCAs makes it difficult to characterize them. Most attempts do not explicitly distinguish between the tenure, management and purpose of PLCAs (Carter et al. 2008).

Stolton et al. (2014) have called for a universal definition of PLCAs in order to facilitate consistent assessments and to better incorporate PLCAs into mainstream conservation: "A privately protected area is a protected area, as defined by the IUCN, under private governance [...]". This definition is based predominantly on a legal approach since according to the IUCN, PAs must offer formal protection on a long-term perspective. PLCAs thus have to meet stringent criteria in order to be acknowledged and officially incorporated into inventories of the global conservation estate. It might be suitable on an international scale to utilise such criteria in creating an accurate record of PLC and determining the degree to which PLC contributes to achieving protection targets. The IUCN definition, however, excludes all other existing privately owned conservation areas from official records even though they may contribute substantially to biodiversity conservation. New classifications are needed to account for the incorporation of conservation lands which do not have formal protection agreements into frameworks, conservation planning and target achievement assessments (Fitzsimons & Wescott 2004).

With respect to both assessments and definitions, a fundamental question arises which we seek an answer to: how can PLCAs be characterized holistically? In order to address this question, individual PLCA characteristics have to be accounted for simultaneously. Characteristics should be investigated in combination and in relation to each other, representing different elements of the overall identity of PLCAs. Further, spatial location and particularly biophysical conditions can substantially influence PLCA identity. Biophysical conditions can act as constraints limiting the development of the entire system into a certain direction. For example, types of habitats and species present in a PLCA may determine the type of ecotourism activities which can be provided for visitors. If not enough visitors are attracted to a PLCA, which depends on generated revenue from ecotourism as main source of economic viability, the persistence of the PLCA might be at risk. In other words, the potential of a PLCA to be viable thus would be restricted by existing biophysical conditions. It is therefore important to understand how PLCA identity is affected by geographical location and spatial variation in relevant influences.

Assessments of PLC should go beyond discipline specific foci and especially no focus should be put on legal status of PLCAs as predominant factor alone. PLCA identity is determined by a myriad of socio-economic and ecological system components. New approaches for assessing PLCA identity can help to account for different corporate models and subsequently to build and maintain desired resilience of PLCAs through various tools.

Understanding the relevance of context is of particular importance to the proposed expansion of the South African PA network, given the vital role which PLC can play for the country with respect to both conservation and societal issues (Chapter 2). Informing planning for an expansion of the conservation estate is also a major objective of the Western Cape Biodiversity Framework in order to meet conservation targets for Critical Biodiversity Areas and Threatened Ecosystems(Pence 2014). Many of these habitats are situated on private land and under threat of agriculture or infrastructure development which highlights the importance of private conservation action. Although there have been several previous studies of PLC in South Africa and the Western Cape Province (for example, Pasquini et al. (2009) investigated the importance of support structures and incentives to PLC in the Western Cape Province, and Knight et al. (2010) assessed the willingness of private landowners to collaborate and participate in conservation in the Eastern Cape Province of

South Africa) these analyses did not try to categorize PLCAs or to assess their identity comprehensively in relation to their potential resilience and sustainability.

In Chapter 2 I showed that PLCAs in the Western Cape Province differ depending on whether or not they stock large mammals and offer safari-type ecotourism with game drives. The next step in this line of exploration was to ask whether these two potential groups of PLCAs differed significantly in a broader variety of identity components. I expected the location of a PLCA to have a substantial influence on its identity. I hypothesized, (H0), that the two potential groups of PLCAs in the Western Cape Province would differ significantly in various identity components and that they emerge because biophysical conditions substantially determine their corporate model. Alternatively, (H1), no distinct PLCA types would be identifiable and differences in PLCAs would emerge on a continuum because biophysical and other factors of location are only playing a relatively small role in PLCA identity.

3.2 Data and Methods

3.2.1 Defining PLCA Identity

In order to know whether and how a system has changed, it is essential to first have a clear idea of what the system is. PLCA identity can be defined based on the framework developed by Cumming & Collier (2005), Cumming et al. (2005), Cumming (2011) and (De Vos et al. 2016a) which is described in more detail in Section 1.3, Chapter 1. The current analysis focuses primarily on the system components of PLCAs (Table 1); the remaining three elements (relationships, continuity and innovation) are subject of subsequent chapters. Table 1 comprises major aspects of the framework with some explanatory details. The list is not complete and can easily be expanded with further attributes for each element (e.g. location for components, economic viability for continuity). There are multiple hypothesized means of building and maintaining desired resilience in SESs, especially considering sources of continuity and innovation which link to the concepts of adaptive capacity (e.g., Folke et al. 2002; Lebel et al. 2006; Keys et al. 2014; Biggs et al. 2015). Table 1 describes these two elements coarsely as they incorporate a diverse set of potential options and measures.

Table 1: General elements and attributes of PLCA identity (modified from De Vos et al. (2016a)). The presented list highlights main attributes and is expandable.

Element	*Attribute*	*Description*
Components (parts and characteristics of the system; entities/factors affecting the system)	Biotic environment	Species composition and abundance, habitat types
	Abiotic environment	Soil and typographic settings, aquatic system, nutrient cycling, climate
	Built environment	Infrastructure, fences, facilities
	Beauty, scenery	Aesthetics of the habitats/landscape contained or surrounding the PLCA
	Landowner and/or manager	decision maker(s) maintaining and managing a PLCA
	Economic settings and business approach	Revenue, income type, employment, activities offered
	Size and age	Area extent and long-term existence
	Area users	People who visit a PLCA or make use of it in another way, e.g. research, harvest of natural products, tourism
	Local communities	People in proximity to a PLCA, e.g. farmers, villages
	Political environment	Relevant legislation, legal status, and policy
	Collaborators	Any entity/person interacting with the PLCA
Relationships (links between components)	Ecosystem processes	Predator-prey relationships, inter- and intra-species competition, interaction between biotic and abiotic environment, nutrient cycling, fire regimes
	Management	Actions taken by owners/managers regarding built and biotic environment, as well as local communities in the form of benefit sharing activities
	Interaction	Interaction with external entities/persons regarding the PLCA, e.g. marketing, wildlife trade, research
	User perceptions	perception about the protected area's biotic and built environments from people who use it
	Local community perceptions	Perceptions about the protected area from people who live in the surrounding landscape
	Market access	Potential of reaching diverse clientele,

		conditions of supply and demand
	Payments	Money paid by area users or collaborators
	Societal / political pressures	Pressures exerted by people (e.g. local communities) on authorities, which result in policy/legislation changes
	Economic pressures	Pressures exerted as result of economic goals (e.g. not making profit / desire for greater profit / not meeting targets)
	Clustering	Dynamics and conditions of collaboration and competition among PLCAs and other PAs in proximity
	Enforcement	Process by which legislation compliance is ensured
Continuity (enabling identity maintenance through space and time)	Heterogeneity	Ecological and social heterogeneity, e.g. spatial diversity, cultural diversity
	Connectivity	Ecological and social links, e.g. management interactions, connectedness between patches in the landscape
	Conservation targets / objectives and value systems	Internal and external conservation goals and planning; Societal / cultural values affecting conservation
	Viability	Factors contributing to long-term persistence, such as social and natural capital, economic feasibility, ecological memory
Innovation (supporting novel solutions and responses to change)	Biological adaptation	Past speciation events and present mutation and selection
	Social adaptation	Novel policies, learning, information sharing, medical advances and technology

3.2.2 Analytical Approach

Data used for the present assessment was extracted from the dataset obtained during the personal interviews with PLCA representatives, as described in Section 1.9, Chapter 1. My first aim was to assess whether there was quantitative, multivariate support for the idea of differing PLCA types (corporate models) in the Western Cape Province. Variables relating to socio-economic identity were extracted from the interview data with the aim of representing the entire spectrum of identity components as comprehensively as possible (i.e., capturing the full range of PLCA characteristics; Table 2).

To distinguish the two hypothesized corporate models, I introduced the variable 'mammal drives'. This captured both whether or not a PLCA manages introduced large mammals on site (assessed based on mammal numbers and type of species) and whether it offered guided drives at the same time. Thus, this variable identified PLCAs focusing on safari-type ecotourism based on the stocking of charismatic and extralimital mammals and related activities in comparison to PLCAs which focused on an indigenous setting without introduced wildlife.

Other variables representing the biotic and abiotic environments were excluded from this first assessment step since the second aim was to investigate whether or not biophysical factors influence PLCA corporate models. I also excluded variables that were redundant. For example, hunting, game drives and wildlife trade can only take place if large mammals exist on a property.

Table 2: Variables representing socio-economic identity components

Name of variable	*Category of identity components*
Number of facilities	Built environment
Manager on site (yes or no)	Landowner and/or manager
Number of staff	Economic settings and business approach
Number of tourism activities	Economic settings and business approach
Mammal drives (yes or no)	Economic settings and business approach
Self-sufficient (yes or no)	Economic settings and business approach
Number of marketing tools	Economic settings and business approach
Size	Size and age
Age	Size and age
Number of tourists	Area users
Number of international tourists	Area users
Gazettement (yes or no)	Political environment
Management plan (yes or no)	Political environment
Number of interactions with other protected areas	Collaborators
Number of interactions with other entities	Collaborators

I ran a Principal Components Analysis (PCA) on all included variables (n = 15) to reduce their dimensionality and then assessed ordinations of principal components to determine whether or not the sample of PLCAs could be divided into groups based on identity-related variables (Shlens 2005; Abdi & Williams 2010). The PCA was conducted in the statistical software R, version 3.1.0 (R Core Development Team 2014), using the packages **vegan** and

ggplot2 (Oksanen et al. 2013; Wickham & Chang 2015). Because of covariance effects, I then assessed original individual variables for significance (t-tests of means for continuous data, Chi-Squared-tests for categorical data) in defining PLCA types.

The same 15 variables were used in a clustering analysis that created PLCA categories (Hartigan 1975; Xu & Wunsch II 2005). Clustering analysis refers to a set of techniques for grouping data according to their similarity or dissimilarity, which was conducted in R using the function *hclust*. Hierarchical clustering analysis was employed since it is the method most suited to grouping multiple types of variables - counts, continuous variables (e.g. size) and binary variables. For my dataset, agglomerative hierarchical clustering was used. In this type of clustering, each individual unit is in its own cluster at the beginning, and then larger clusters are formed by grouping individuals. This represents a 'bottom-up' approach in which Euclidean distance was used. The latter is mostly applied to numerical and mixed data sets. Ward's method was employed for the clustering criterion as it minimises the variance between the units of a cluster which is a desirable trait.

To test whether or not biophysical factors significantly influenced PLCA identity (i.e., whether or not membership in a group of PLCAs can be explained by ecology and location) I utilised a set of variables representing the biotic and abiotic identity components. This set consisted of 'river', 'waterbodies', 'land cover classes', 'elevation', 'fynbos' and 'travel distance to coast'. The number of land cover classes, number of water bodies and the presence of rivers in PLCAs as well as the dominant biome (Fynbos or not) were calculated in ArcGIS 10.0 using the following datasets: the Vegetation Map of South Africa, updated version 2012 beta (SANBI 2016), a modified version of NFEPA wetlands layer 2011 (1:50000; (BGIS 2015) and the river layer from South Africa's National Freshwater Ecosystem Priority Areas project (1:50000; (BGIS 2015). The travel distance in minutes to 'coast' was generated in GoogleMaps using the travel route calculator. Elevation of PLCAs has been calculated using the online tool GPS Visualizer (Schneider 2015).

As before, I tested the contribution of each individual variable to category membership by applying t-tests for all continuous variables and Chi-Squared-tests for the categorical variables 'fynbos' and 'river'.

3.3 Results

3.3.1 PLCA Typology

The first and the second principal components in the PCA explained 38% of the variation in the dataset. From the biplot (Figure 1) it became apparent that two of the 15 variables, namely ‘age’ and ‘gazettement’, had opposite effects than the remaining 13 variables. This means that PLCAs can be distinguished based on the grouping of these variables, into a group which is predominantly older and more often gazetted versus a group which is better described by the remaining 13 variables. Generally, the variables 'mammalsdrives', 'facilities', 'staff', 'visitors', 'tourism-international', 'interactions-entities', and 'gazettement' were of highest importance for explaining variation among PLCAs.

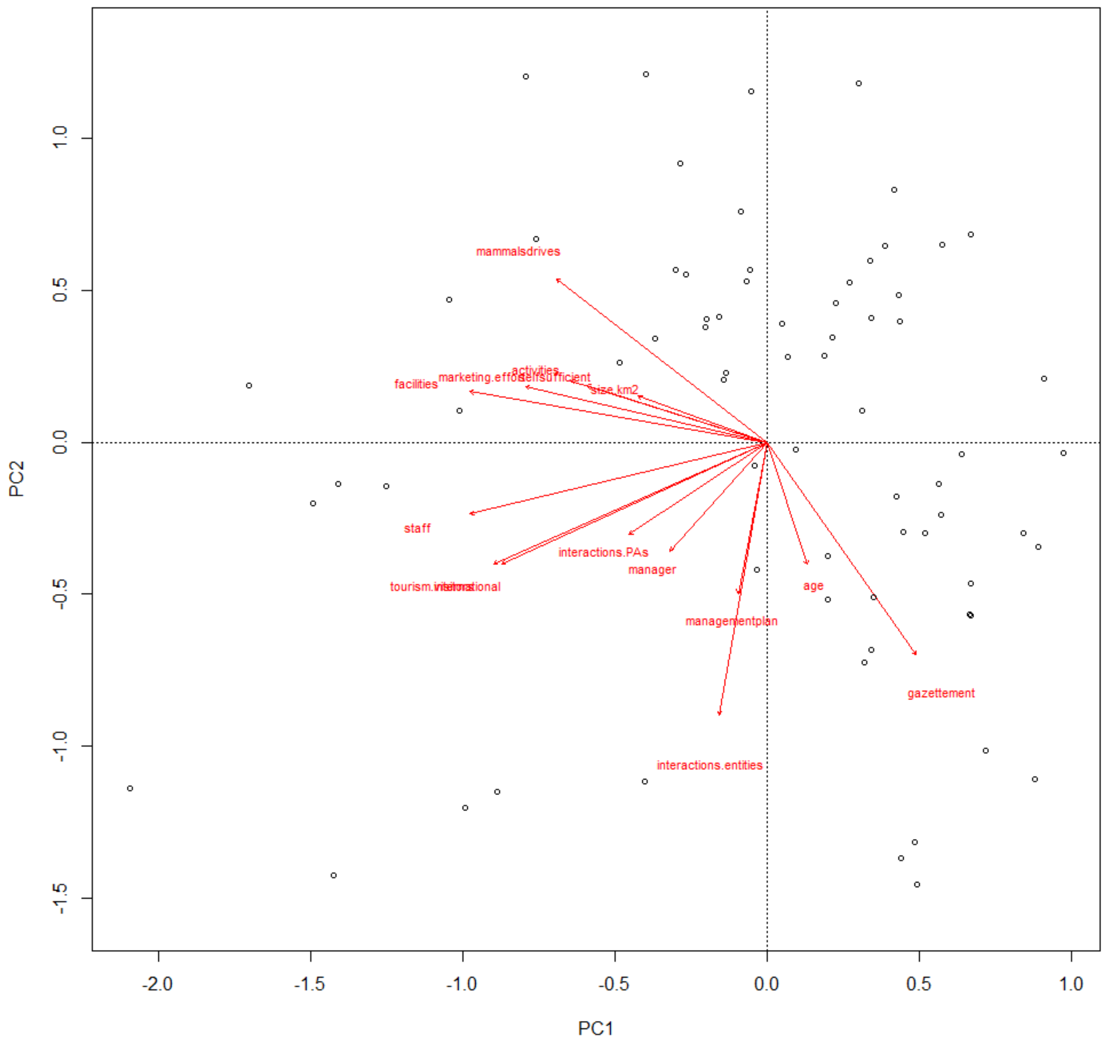


Figure 1: Plot of the first and second principal components resulting from a PCA of PLCAs in the Western Cape Province, using 15 variables describing system components of these areas. PLCAs are shown as numbers and variables as vectors.

The cluster analysis successfully divided PLCAs into two groups (namely game and habitat reserves), based on similarity measures according to the 15 previously described variables (Figure 2). However, a few game reserves clustered amongst habitat reserves and vice versa. Cluster 1 (left) contained mostly habitat reserves, and Cluster 2 (right) mainly contained game reserves when identified according to PLCA-IDs (77% correct). In total, eight PLCAs occurred in the wrong category, meaning that they were defined as game reserves although they did not stock large mammals in reality and vice versa. In cluster 1, the PLCAs with IDs 41, 49, 50, 53, 60, 62, 69 and 70 were categorized as habitat reserves, although being game reserves in reality. In cluster 2, the PLCAs with IDs 1, 5, 13, 14, 15, 22, 25 and 27 were categorized as game reserves although being habitat reserves in reality. The overall success of correct clustering was significant (p = 0.0001).

When carefully assessed further, six out of the 15 variables used in the PCA and clustering analysis offered significant discrimination between groups of PLCAs (either game or habitat reserves as represented by the variable 'mammal drives’). Game reserves, as opposed to habitat reserves, were characterized as those offering more types of facilities and activities, having more staff members, using more marketing tools, being larger in size, and being less often gazetted (Table 3).

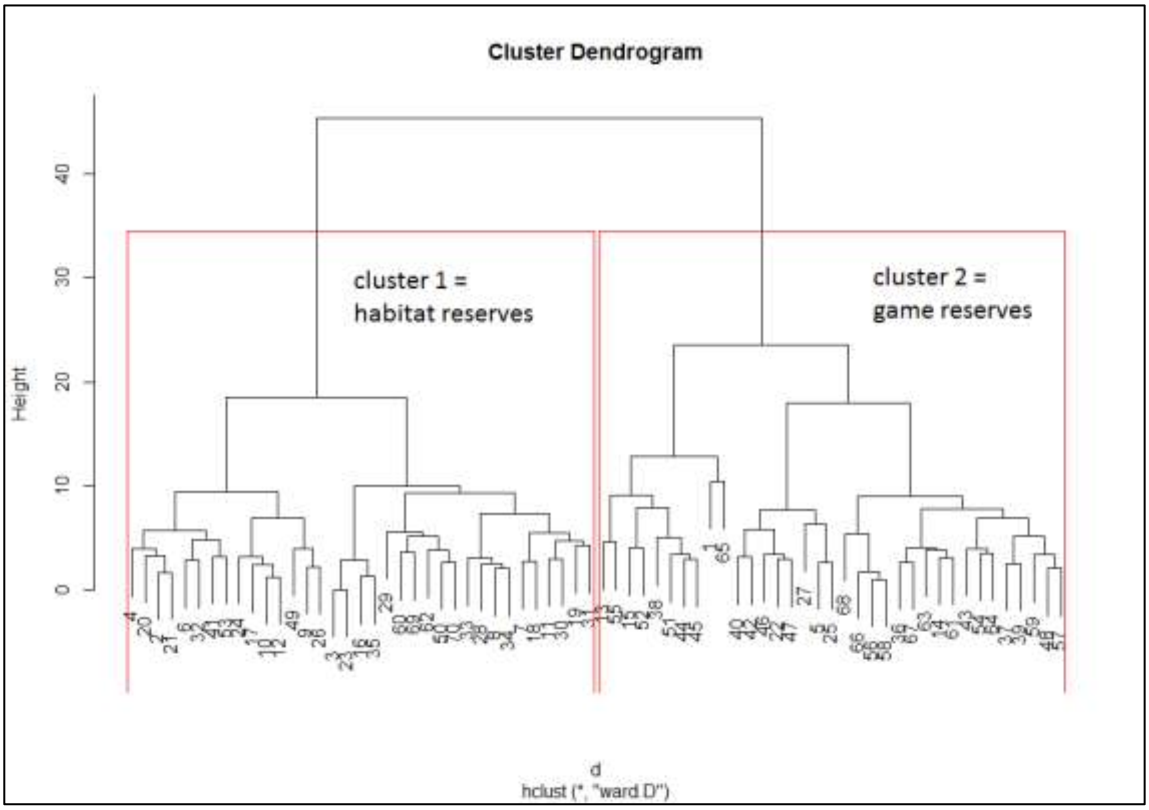


Figure 2: Clustering plot, significantly distinguishing PLCAs in the Western Cape Province into habitat reserves (left) and game reserves (right).

Table 3: Values of significance for all identity component variables used in the PCA

Significance value	*Name of variable*
p < 0.01	Number of facility types (p = 0.0004)
	Size of PLCA (p = 0.001)
	Number of activity types (p = 0.008)
p <= 0.05	Number of staff members (p = 0.01)
	Gazettement (yes or no) (p = 0.021)
	Number of marketing tools (p = 0.022)
p > 0.05	Number of international tourists (p = 0.101)
	Self-sufficient (yes or no) (p = 0.455)
	Age of PLCA (p = 0.170)
	Number of tourists (p = 0.194)
	Manager on site (yes or no) (p = 0.71)
	Number of interactions to protected areas (p = 0.607)
	Number of interactions to other entities (p = 0.760)
	Management plan (yes or no) (p = 1.000)

3.3.2 The Influence of Biophysical Factors on PLCA Typology

Internal biotic and abiotic identity components did not have a substantial influence on the PLCA typology. Game and habitat reserves could not be distinguished by the existence of rivers, number of waterbodies, number of land cover classes or topographic elevation inside property boundaries. None of these variables showed statistical significance when tested for differences between PLCA types.

Broader biophysical conditions, however, showed a significant relation to the typology. Habitat reserves were significantly more common inside the Fynbos biome ($p = 0.001$) when compared to game reserves. Only 8.5% of the habitat reserves occurred outside the Fynbos biome. In comparison, 43% of game reserves were located in other habitats such as karoo or thicket. Further, the distribution of habitat reserves in proximity to the coast was significant (travel distance to coast: $p = 0.006$) whereby they were located closer to the coast than game reserves.

3.4 Discussion

In the Western Cape Province, two main types of PLCAs could be identified which substantially differed in several identity components. Six variables differed significantly between PLCA types. Game reserves, offering safari-type ecotourism with large mammals and guided drives, were characterized as (1) providing more facility types and (2) activity types, (3) having more staff members, (4) using more marketing tools, (5) being larger in size and (6) less often gazetted in comparison to habitat reserves. These findings were verified by both the PCA and the clustering analysis. The PCA identified trends of correlations among variables, whereas the clustering analysis directly grouped PLCAs into types with significant success. In the cluster analysis, only eight PLCAs were categorized as game reserves while being habitat reserves in reality, all other PLCAs were categorized correctly. These eight PLCAs had similar characteristics as game reserves (i.e. high visitation, many activities provided, many interactions to other PAs) and where thus identified as such, however, did not stock large mammals on the property. Table 4 summarizes and expands these main findings by adding some qualitative aspects which were obtained during interviews with study participants.

The PLCA typology was furthermore shown to be influenced by factors of location. Internal identity components representing the biotic and abiotic settings, such as the number of waterbodies or land cover classes, were not found to be significant. Instead, the dominant biome and the distance to the coast were significantly different between PLCA types. Habitat reserves were situated more often in the Fynbos biome, and thus also closer to the coast when compared to game reserves.

I could therefore verify the null hypothesis which stated that different types of PLCAs exist in the Western Cape Province which differ significantly in various identity components, whereby ecological features (represented by the variable 'mammal drive') and corresponding biophysical conditions (i.e. dominant vegetation units) played a substantial role.

Table 4: Comparison of crucial attributes of identity which distinguish PLCA types in the Western Cape Province (game vs. habitat reserves)

Attribute	*Game Reserve*	*Habitat Reserve*
Biotic environ-ment	stocked wildlife; BIG 5-species (13 PLCAs); charismatic and extralimital species situated more outside Fynbos (43%), in Karoo and Thicket	indigenous species; focus on endemic flora and fauna; seldom wildlife translocations situated more inside Fynbos (91.5%), closer to coast
Built environment	drivable tar or dust roads; adequate enclosure certificates for large mammals; specific fencing advanced facilities (e.g. lodges, restaurants, shops, pools, airstrip)	few roads; many trails no enclosure certificates necessarily; normal or no fencing often camping, self-catering chalets
Landowner /manager	management often by general/ lodge/ conservation managers	often managed by landowners
Economic settings and business approach	mostly profit-oriented; focus on safari-type ecotourism with guided tours; wildlife trade; hunting; events commonly large staff (mean: 26 staff members) sometimes gazetted (8 PLCAs)	less profit-oriented; sometimes other profession; focus on outdoor activities (e.g. mountain biking, birding), heritage sites (e.g. rock art), events/weddings, education rather small staff (mean: 8 staff members) often gazetted (26 PLCAs)
Size	often large (mean: 58 km2)	smaller (mean: 15 km2)
Area users	many visitors (mean: 6700); commonly international tourists	less visitors (mean: 3500), international and local tourists; researchers
Collaborators	tourism bodies, game capturers /veterinarians, companies, other PAs	tourism bodies, research /education, other PAs
Management	wildlife trade, alien clearing, anti-poaching, species population regulation, monitoring; mostly management plan	alien clearing, prescribed fire use, monitoring, natural products; not always management plan
Market access	often high-end low-volume tourism	often low-end tourism
Economic pressures	higher maintenance and management costs due to stocked wildlife; however, often more profitable	often lower costs; however, also lower income generating potential; often not viable and additionally funded
Enforcement	due to stocked wildlife: enclosure regulations and permits/licenses	if gazetted: regulations due to binding conservation agreement

The typology represents different corporate models of PLCAs resulting from contrasting biophysical conditions. Corporate models can determine the economic viability of PLCAs. Since conservation is costly, and PLC often does not receive state support, ways of compensating for these costs or making a net profit have to be found for PLCAs. Game reserves have a corporate model which relies on stocking charismatic species. These can enhance the revenue generated through ecotourism, and thus potentially contribute to financing conservation action (Van der Waal & Dekker 2000; Lindsey et al. 2005, 2007). The necessity of stocking charismatic species for attracting visitors and especially their overstocking have, however, been questioned in other studies and are of concern (Maciejewski & Kerley 2014b). The trend of habitat reserves being located significantly more often within the Fynbos further suggests that the vegetation offers a high potential for the provision of cultural services through ecotourism activities such as hiking, mountain biking, or birding. An interesting attraction of the Fynbos biome is the flowering season which brings many visitors to the Western Cape Province. Thus, habitat reserves might not experience the need to create income by introducing large mammal species. Contrarily, one could argue that habitat reserves being situated in the Fynbos have a low opportunity cost, i.e. the ecological features are not suitable for other activities. Fynbos vegetation is growing on fairly nutrient poor bed rocks in a winter-rainfall region (Soderberg & Compton 2007; Richards et al. 2009), which may not offer suitable habitat for many large mammals, notably for Big 5-species (e.g. Boshoff et al. 2002) or the ability to support viable populations. The fact that many PLCAs, especially game reserves, are not gazetted with official conservation programmes can be interpreted in relation to economic viability as well. Habitat reserves employ less disturbing facilities and activities in ecotourism than many game reserves and thus are less challenged to manage their properties conform to current conservation regulations. Game reserves may face more challenges to fulfil conditions of gazettement due to introducing certain species or developing infrastructure on their property. Enrolling in conservation programmes can potentially restrict them in running their business according to the adopted corporate model.

In general, it is not apparent whether or not the adopted corporate model is chosen *a priori* (i.e. prior to land purchase for establishing a PLCA) or limited by biophysical factors post-fixed (i.e. in an already established PLCA). This means for example, a person planning to establish a game reserve might choose a suitable property with the objective of stocking charismatic species and would thus consider properties with a certain size or habitat type. Contrarily, biophysical conditions might limit the potential future development of a PLCA. A landowner may choose to change land use of an agricultural property into a PLCA, however, might face unsuitable conditions to do so. Or a person inherits or buys a property which was originally not meant to have wildlife stocked. With the new aim to introduce large mammals at a later stage the landowner may then also face unsuitable conditions.

The dominance of biomes as an influence on the PLCA typology in the Western Cape Province might be further linked to other spatial conditions and influences which could explain the distribution of PLCA types across the region. Many PLCAs are established on former agricultural land (Chapter 2). The Karoo is historically a high production landscape for agriculture and pastoral systems. As agriculture is becoming non-profitable, landowners shift to game farming (Carruthers 2008). Properties are potentially large in size and therefore more suitable, also with respect to open spaces potentially created by former cattle ranching. Contrarily, within the Fynbos region, properties are in closer proximity to infrastructure and a mosaic of land-uses which may not allow for the establishment of large PLCAs. Closely related issues are the availability of land for acquisition, the need for supplementary fodder for large herbivores and whether landowners have sufficient funds for land purchase or property expansion available (Knight et al. 2011). Value of land affects decisions about establishment or land-use change of properties into PLCAs (Chapter 2).

What becomes apparent from my findings is that the structure and functioning of PLCAs is not solely governed by either ecological or socio-economic characteristics. A combination of characteristics and their interactions, as well as influences from other scales determine PLCA identity (Cumming et al. 2015b). For building resilience of PLCAs it is important to identify and account for interactions and cross-scale influences. Understanding and supporting different PLCA types can contribute to maintaining diversity and redundancy within the entire conservation system. Accounting for different PLCA types can also enhance learning through knowledge sharing within networks of PAs and other stakeholders. Suitable management strategies can be developed and implemented which speak to specific challenges faced by PLCAs depending on their adopted corporate model.

The applied identity approach was suited to better understanding PLC on a local scale, but could well be utilised beyond this case study. It is a tool that can provide comprehensive insights into the structure and functioning of (not just private) PAs, particularly when related to spatial variables. Other assessments of PLC in South Africa and abroad have not used such a comprehensive approach and leave the overall identity and PLCA typologies undefined. In Australia, for example, Moon & Cocklin (2011), differentiated between private landowners according to whether or not they generated income from their properties in order to assess similarities or differences between these two groups which might inform the use of policy instruments for conservation programme design. Tecklin & Sepulveda (2014), for example, discussed the challenges faced by PLC in Chile, mostly concerning its historic development, property sizes and property rights. Similarly, for example Carter et al. (2008) or Fitzsimons & Wescott (2004) developed PLCA typologies based on socio-economic characteristics such as tenure regimes.

Emphasizing legal PLC definitions based on single characteristics such as tenure type, which is the case internationally (Stolton et al. 2014), may be a suitable tool for the assessment of statutory conservation with respect to target achievements. Non-formal areas, however, may provide strong potential for the improvement and enhancement of statutory PA networks and can offer a target for new conservation strategies and flexible conservation planning. Fostering connectivity in this regard can be a further option for building resilience in SESs, such as conservation networks (Biggs et al. 2015).

Chapter 4: Nearest Neighbourhood Effects dominate Socio-economic Interaction in Private Land Conservation Networks

4.1 Introduction

With growing global human populations and resource demands, landscapes become highly populated and conservation opportunity is of concern (e.g. Knight et al. 2011). Traditional approaches to conservation have mostly been to maintain and expand the statutory conservation estate (Chape et al. 2005). However, fewer opportunities become available to do so and to increase or extend governmentally- or community-owned protected areas (PAs). Private land conservation areas (PLCAs) offer an intriguing alternative, but their potential for biodiversity conservation is often overlooked (e.g., Lindsey et al. 2014). The preferred mechanism of many conservation-related initiatives focused on private lands (e.g. NGOs such as The Nature Conservancy, World Wildlife Fund) has been to purchase private land and place it under governmental management rather than to foster private land ownership and conservation action. Until recently, PLCAs are also not incorporated in inventories such as the UNEP-WCMC World Database on Protected Areas (Stolton et al. 2014) due to being perceived as less effective with respect to factors such as long-term persistance (Kreuter et al. 2010).

PAs function as networks within a wider conservation system. Many interactions in social-ecological systems (SESs) take place at similar scales, but processes and actors at finer or broader scales influence pattern-process interactions via flows of material and information between nested elements as well as via horizontal and vertical linkages (Young 2001; Cumming et al. 2015b). Such flows can substantially influence or change the structure and functioning of PAs. For example, an outbreak of a wildlife disease may diminish large mammals stocked in PLCAs and thus weaken the ecotourism success (i.e. decrease the numbers of attracted visitors) and corresponding generated economic revenue. Subsequently, individual PLCAs might have to close down business and change land use into more viable options which would mean a loss of conservation land.

An investigation and understanding of conservation networks can answer questions about which areas in a system of concern are of major importance, how communities can be linked and which degree of interaction or ‘connectedness’ is most desirable. This allows for better regulating information and material flows and for dealing with perturbations. Subsequently, maintaining and enhancing desired resilience of the system can be achieved since one option for building resilience in SESs is to manage connectivity (Biggs et al. 2015).

Connectivity, in both ecological and socio-economic contexts, is essential for biodiversity conservation in the realm of implementation and maintenance of PAs (Margules & Pressey 2000). Spatial ecological connectivity ensures that ecological processes and functions continue to occur across landscapes. For example, the dispersal of species between habitats contributes to the maintenance of gene flow in meta-populations (Laurance et al. 2012). PAs in this context can serve as stepping stones or corridors (e.g. Rouget et al. 2003), and can be understood as a network of patches within a matrix of surrounding landscape with which they are interlinked (Prugh et al. 2008).

Similarly, conservation policies and practices are inherently social phenomena (Mascia et al. 2003), and PAs can be perceived as "a way of seeing, understanding, and producing nature (environment) and culture (society) and as a way of attempting to manage and control the relationship between the two" (West et al. 2006). Socio-economic connectivity generally contributes to the development of shared conservation knowledge, general objectives and conservation practices as well as viability of action across scales (from private to governmental and local to international levels), especially when systems differ among each other, for example according to PLCA corporate models (see Chapter 3). Economic connectivity occurs via visits by tourists, who often visit PAs sequentially or as part of package deals; through direct economic exchanges; through wildlife translocations, which serve to both generate revenue and resolve under- or overstocking problems (Goss & Cumming 2013); and through incentives from governments and other sources. Social connectivity includes exchanging contacts and management practices as well as the sharing of equipment, labour, and specific expertise. These interactions may be particularly important during times of crisis: coping with a large fire, surviving an economic downturn, or restoring a wildlife population after a pathogen outbreak. Social connectivity can for example help to define frameworks for PA management for worldwide application, such as the IUCN categories for privately owned protected areas (Mitchell 2005).

A major aspect of socio-economic connectivity is the direct interactions among PA owners and managers and with other stakeholders (such as tourists, researchers, environmental consultants, companies, policy makers). These interactions represent relationships which shape and help to maintain the identity of a SES (Cumming & Collier 2005; Norberg & Cumming 2008; Cumming 2011). They play an important role for the continuity of PAs, e.g. through improving PA management or ensuring long-term economic viability (Walker et al. 2004). These socio-economic interactions can be influenced by spatial factors and incorporating the heterogeneity paradigm into conservation is essential (Rogers 2003). Clustering, i.e. spatial proximity, in networks creates the social conditions for interactions and generally manifests in three ways: it may cause competition, create collaboration or enhance the establishment of new PAs (Cooke et al. 2012). Similar ecological settings such as habitats or a focus on the protection of a certain species may thereby represent biophysical reasons for collaboration. For example, in the Eastern Cape Province of South Africa, several PLCAs collaborate within an established association called Indalo (Indalo 2016)

According to Lauber et al. (2011), interactions in networks undergo evolutionary phases (i.e. at the beginning (opportunistic phase) new opportunities for interaction are seized; subsequently these new interactions may become institutionalized (conservation phase); this however may make adaptation to changed conditions difficult and interactions may start to break down and transform into adverse behaviour (release phase). Finally, new interactions can be developed (reorganization phase).

There is a lack of information about social-ecological connectivity of PLCAs. Their owners and managers interact about socio-economic and ecological topics, but no detailed information on the *status quo* (i.e. intensity and topics) or hidden potentials for collaboration is available. An understanding of such interactions is nonetheless highly relevant for PLCA resilience. It provides insight about the strength and weakness of current networks as well as about options for innovative action.

I assessed the socio-economic interaction networks between PLCAs and other entities (i.e. stakeholders such as government, research institutions and companies) in the Western Cape Province of South Africa. The province faces challenges of falling short for targets for conservation and needs to identify and expand areas for protection (Pence 2014). In general, very little is known about engagement in conservation collaborations and other types of interactions from the perspective of PLC. The enhancement of an internal network in PLC as well as an external network to other PAs and stakeholders across scales has the potential to strongly strengthen conservation efforts and successes (e.g. Lauber et al. 2011). I thus examined these networks in which information and resources are transferred in respect of their strengths, weaknesses and potential.

It was expected that nearest neighbour effects play an important role for fruitful interaction among PLCAs and other stakeholders. Other strategy selections for interaction could be to follow the dominant option (e.g. most successful PLCA corporate model), to choose randomly (based on self-interest without consideration of surrounding PLCAs), or to distinguish between preferences in ecological and socio-economic connectivity. Furthermore, existing networks were thought to show a high potential for further enhancement and expansion of interaction. I hypothesized (H0) that interaction was dominated by positive nearest neighbourhood effects as opposed to competitive effects. PLCAs which are closer to one another in geographic space will also be more closely connected through social and economic networks, because the majority of mutually beneficial interactions in the network are facilitated by spatial proximity. Contrarily, (H1), spatial location and proximity were hypothesized to not substantially determine interaction. Instead, membership in communities might drive the dominant pattern because interaction is determined by certain topics of common interest (e.g. stocking large mammals), similar ecological conditions, or similar management and corporate models. Alternatively, (H2), I hypothesized that a combination of both nearest neighbour effects and membership in communities would determine the structure and functioning of PLC networks.

4.2 Data and Methods

I used social network analysis to investigate interactions among PLCAs and between PLCAs and their partners. Social network analysis is based on graph theory. It treats PAs as nodes and interactions as links, and focuses on how a collection of units interacts as a single system (Proulx et al. 2005; Boccaletti et al. 2006; Cumming et al. 2010). Network metrics helped to identify strengths, weaknesses and potential as well as scales of interaction. I then investigated the frequency, types, and topics of interactions. Finally, GPS coordinates were added to test for a geographic neighbourhood effect.

4.2.1 Data

Information and data provided by the sample of 70 PLCAs (see section 1.9, Chapter 1) were used to analyse and visualize interaction networks. Thirty-five of the study participants can be characterized as game reserves, the other half as habitat reserves (Chapter 3).

Participants were asked to provide names of all other PAs (including national parks and provincial reserves) and entities (such as research institutions, companies) with which they were interacting and how frequently [Original interview questions: a) 'Please list 5 other protected areas you yourself regarding your job/ position mainly interact with, since when you interact and how frequent'; General Questionnaire. b) 'Do you know/ interact with other private areas not on the list above? Please state them here. They may be located anywhere in South Africa'; Interaction Questionnaire. c) 'Please list: 5 names of entities of any type you mainly interact with regarding your job/ position in the park, since when you interact (previous to current job or earlier, year if possible), how and how frequent'; General Questionnaire]. Study participants also had to define the types and topics of each interaction (Table 1).

Table 2: Categories for frequency, type and topics of interaction among PLCAs and other actors. (Original interview questions: a) 'Which topics of direct socioeconomic interaction occur between you and these reserves?' and b) 'Which topics of direct wildlife interactions occur between you and these reserves?'; Interaction Questionnaire)

Frequency	*Type*	*Topics*
Occasional: sporadic interaction, e.g. only if a fire outbreak occurs and support is needed	*Socio-economic*: interaction regarding staff, tourism, research, knowledge, resources and similar	Collaboration for knowledge Collaboration with resources Education Employment
Frequent: regular interaction, e.g. advice on management practices, referral of tourists for accommodation, collaborative research projects	*Ecological*: interaction strictly in relation to wildlife, ecological problems and similar	Finances Legislation Marketing Research Supply/equipment Tourism Wildlife Other

Participants also provided details about conditions under which interactions took place among PLCAs exclusively. These conditions, e.g. a positive relation to the collaborator or support concerning invasive species management, were rated according to their importance on a scale from 1 (not relevant) to 5 (very important). Ratings provided insights into motivations and restrictions for interactions among private landowners, which may be relevant for an improvement of internal networks to support and strengthen individual conservation action without the interference of external stakeholders.

Where GPS coordinates were not available from collected information they were sourced via search tools such as GoogleMaps and GoogleEarthPro, particularly for PAs and entities which were not part of the study sample and had therefore not been contacted directly.

4.2.2 Networks

A network is comprised of nodes (vertices, actors) and edges (links, connections). Entities represent the individual components of a network, such as persons or areas. These are connected or interact via the edges, e.g. information or material flow (Proulx et al. 2005; Boccaletti et al. 2006; Cumming et al. 2010). Patterns and dynamics within networks can be assessed by analysing network metrics such as degree, density, diameter, path lengths, and centrality (Table 2).

Two main types of networks exist: small-world networks and scale-free networks (Webb & Bodin 2008). Small-world networks show characteristics which place them between typical random graphs and one-dimensional lattices in which each node is connected to all neighbours. The main property of small-world networks is that short paths connect any pair of individuals; just a few steps are necessary to reach a certain node (Amaral et al. 2000). This phenomenon is known as the small-world effect, which commonly holds true for both social and even ecological networks.

Table 2: Network metrics and their meaning for application (Urban & Keitt 2001; Boccaletti et al. 2006; May 2006; Vance-Borland & Holley 2011)

Network metric	*Details*	*Meaning for application*
Degree	Number of edges connected to a node	Do hubs or unconnected nodes exist in the network: How well connected are individual PAs for resource sharing or which ones are isolated?
Diameter	Longest of shortest paths	How easily and far can information or resources traverse a network: For example, does a disease outbreak spread from a certain PA to another one or to all PAs in the network?
Average path length	Average number of edges between any pair of nodes	How many edges have to be traversed to reach any other node: For example, how long does it take until disease spreads to all PAs?
Centrality	Number of times a node acts as a bridge along the shortest path between two other nodes	Which are the important nodes of the network: Which PAs are main actors in collaboration and provide links with other PAs?
Community	Nodes of the network can be grouped into groups of nodes where each group of nodes is densely connected internally	How many sub-networks exist: Which and how many PAs form communities or local geographical clusters?

Scale-free networks follow power-law distributions where the degree distribution, i.e. the distribution of the number of links to each edge, is not random (Proulx et al. 2005). Most of the nodes have few links and the number of nodes declines exponentially with increasing degree, producing a skewed degree distribution (Webb & Bodin 2008). Few nodes are connected to many other nodes, a situation that has consequences for the resilience of the entire system (Bascompte 2007): if these highly linked nodes (hubs), which in many cases connect compartments (sub-networks) are removed, the system may be fragmented into disconnected parts. Another characteristic of scale-free networks is incremental growth, i.e.

separate networks can be combined to a larger one by connection through single additional nodes. Further, preferential attachment occurs, meaning that new nodes probably get connected to already highly linked nodes (Barabási 2009). In general, every node may be part of several sub-networks. This trend may produce intermediate modularity of the entire system which is expected to strengthen resilience.

Numerous existing networks within society and nature show two main characteristics: they are scale-free and display a high degree of clustering (Ravasz & Barabási 2003). These characteristics, in particular combined with spatial aspects, are of main interest to conservation practices such as a PLC network. Network analysis can yield increasingly interesting and important insights for conservation biogeography. Generally speaking, graph theory has the potential to immediately influence pressing problems in conservation as it is already well developed in other disciplines (Urban & Keitt 2001). This approach has never been utilised to investigate interaction among PLCAs in South Africa in order to understand their role in the conservation system.

4.2.4 Data Analysis

<u>Network structures</u>

First, I analysed the overall network of all social-ecological interactions of PLCAs to other PAs. Every interaction represented one edge in the network regardless of other characteristics such as the frequency, type or topics of interaction. To determine how easily, or how far, information can traverse the network I calculated network diameter, which can also be defined as the maximum number of links that connects any two nodes (Janssen et al. 2006). I also calculated the average path length, or average number of edges between any two nodes (Rayfield et al. 2011), to determine how many edges have to be traversed to reach any other node (Table 1).

Second, I subdivided the interaction dataset according to the PLCA typology into two communities (one of game reserves and one of habitat reserves) in order to detect specific aspects. I also assessed whether or not interactions take place between different levels of authority in the governmental conservation hierarchy (national, provincial or private PAs), i.e. across scales or rather in communities of PAs such as mainly PAs with BIG5-species.

Third, the same procedure was applied to the interaction networks of PLCAs with other entities. Here the dataset was also subdivided into game and habitat reserves and entities were grouped into different types (Table 3).

Numerical network analysis was conducted in R (R Core Development Team 2014), version 3.0.0 using the package **igraph** (Igraph Core Development Team 2015) with several different functions to calculate characteristic network metrics (Table 2). The significance of network metrics was determined relative to the null hypothesis that network structure was random. In practice this involved generating a null data set of 1000 random networks (bootstrapping with 1000 permutations) using the Erdös-Rényi algorithm, which preserves the number of nodes and edges in the real network while randomly modifying edge locations (Erdös & Rényi 1959), and comparing results from my 'real' data to those from these random networks. Bootstrapping was conducted in R with the function *boot()*.

Table 3: Types of interacting entities identified by PLCA owners and managers

Type of entity	*Details*
associations/societies	Organisations/groups related to knowledge sharing, research, partnerships, providing communication platforms for like-minded actors, e.g. botanical society, water user association
conservation/legislation	Initiatives/institutions related to implementation of conservation action, partly involved in providing knowledge about or applying legislation, e.g. conservancy, experts, NGO, protected areas
education/research	Institutions/organisations concerned with education or research, e.g. schools, universities, councils, training projects
government/legislation	Institutions related to legislation, e.g. municipality, government department
local network	Stakeholders in spatial proximity, e.g. neighbours, communities
supplies/business	Companies/actors related to business and infrastructural topics, e.g. civil engineers, supermarket
tourism/marketing	Actors related to tourism and marketing, e.g. tourism office, hotels
wildlife trade/hunting/breeding	Organisations/actors related to wildlife, hunting and breeding, e.g. outfitters, hunting association, game capturer

Results are reported for directed network graphs because interactions were solely known from the perspective of the participating PLCAs. PAs which were not part of the sample were not contacted to confirm these interactions. All results and graphs further include study participants which do not interact with any other PA, to assess the overall interaction performance of the sample. Twenty-one PLCAs (12 habitat reserves and 9 game reserves) stated that they had no interaction with other PAs. Visualization of the results was mainly undertaken in Gephi (Bastian et al. 2009).

Neighbourhood effect

Studies have suggested that spatial distance plays a role in influencing the probability, contact frequency and strength of social ties (McPherson et al. 2001; Maciejewski & Cumming 2015). In order to test whether a neighbourhood effect exists for interaction among PAs in the entire conservation network, I first applied the function spdist (Pebesma et al. 2014) in R to calculate the Euclidean distances in kilometres between all individual nodes (i.e. all PAs in the assessed network including PLCAs and statutory PAs). The function spdist allows for a calculation of distances between each individual node to each other node in the dataset. I could thus distinguish the distances calculated for connected (showing interactions with each other) versus unconnected nodes. Second, I calculated the average distance between connected nodes versus unconnected nodes in Excel and used a t-test to determine whether the difference in means of distances between connected versus unconnected nodes was significant. Lastly, I assessed the types, topics, and conditions of interaction for different networks and sub-networks in more detail using descriptive statistics in Excel.

4.3 Results

4.3.1 Interaction among Protected Areas

The total PA network consisted of 170 nodes (70 PLCAs of my study sample interacting with 19 national parks, 39 provincial nature reserves and 42 other PLCAs) and 293 edges (interactions). Interactions were not distinguished according to type (e.g. sharing knowledge, wildlife trade); every link in the network represents a general socio-economic interaction between two PAs. This network was characterized by a degree of 3.4, which means that every PA on average had 3.4 links to other PAs. The maximum number of links per PA was 58 and the minimum was 0.

This could also be discovered from the visualized graph (Figure 2), where many PAs were completely remote or just linked to a small number of other PAs within sub-graphs. When weighted by degree, i.e. the number of PAs linked to each PA, the total network showed one most important PA (largest green circle). It represented a PLCA of my sample being the hub of the network with the highest number of links to other PAs. Furthermore, it had most links to other PA types (blue and red circles) and thus incorporated them into the overall network. A few other PLCAs were also quite well connected among each other, which was visualized by their medium green circle size.

The diameter (i.e. the longest of shortest paths) of the real network was 7. This means that it would take a maximum of 7 links to connect one PA with any other PA while traversing the network. A random graph of the same size in comparison had a mean diameter of 20 (standard error = 3.02) which means that information and material would take longer to traverse the network, but would also reach more PAs. The average path length of the real network was 2.7. The mean average path length of a random graph was 5.9 (standard error = 0.58), again showing that it would take more steps to reach PAs in the random graph.

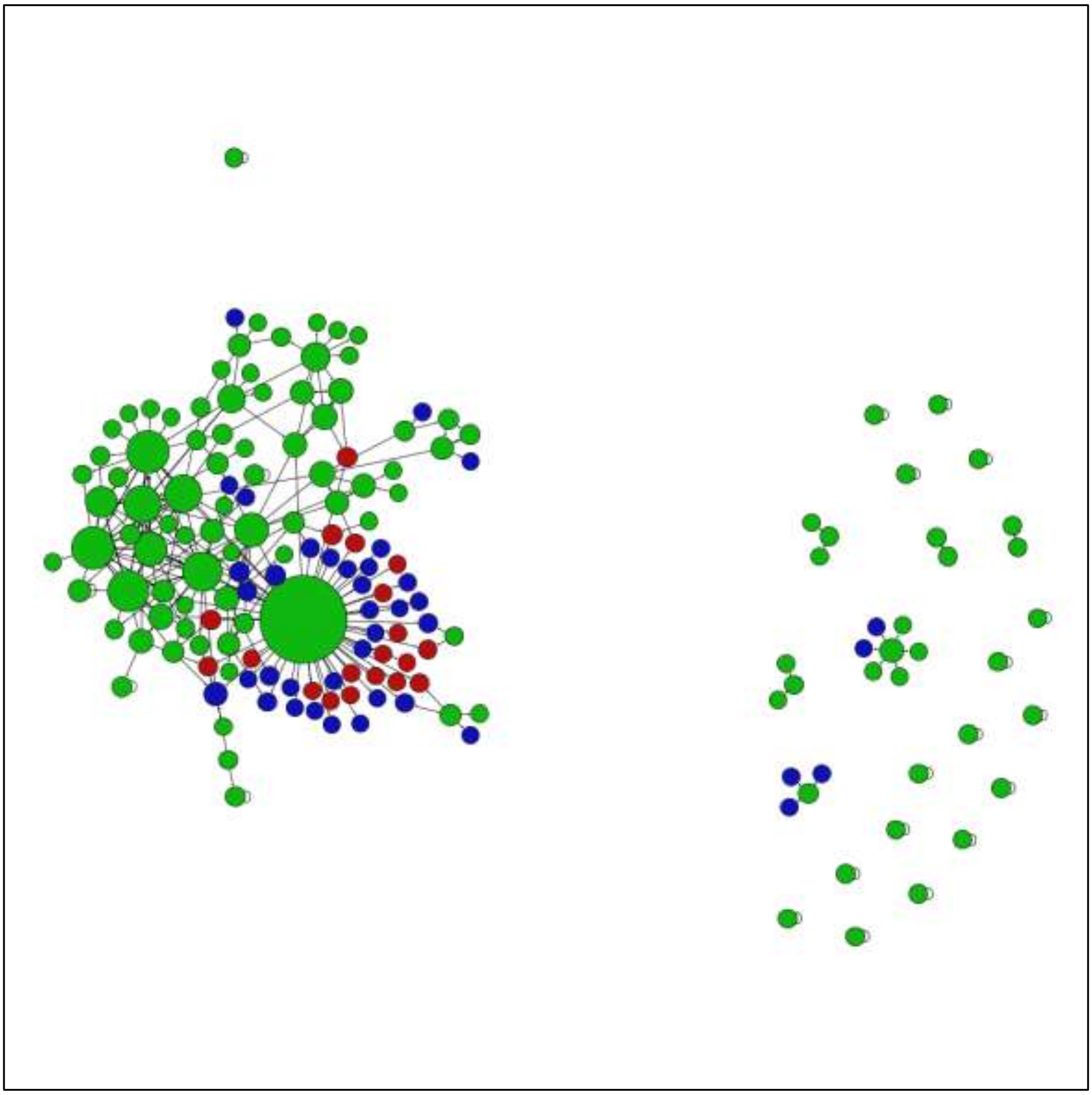


Figure 2: Total PA network of socio-economic interactions in the Western Cape Province, weighted by degree, i.e. the largest green circle represents the PLCA which has the highest number of links to other PAs. PLCAs are depicted in green, provincial PAs in blue, national parks in red. Visualized with Gephi

When weighted by centrality, i.e. the interconnectedness of PAs, the pattern of the total network changed. The former most important PLCA (largest green circle) which had most links to other PAs, became less important. This is due to the fact that the PAs to which it was connected were not well interlinked to other PAs. In comparison to that, the now more important PLCAs (largest green circles) were altogether much better linked among each other, and thus now became more important in the network. These PLCAs can be referred to as hubs of the network. These findings are based on a directed network analysis and thus have to be interpreted from the perspective of PLCAs, i.e. they focus on the importance of interactions established by PLCAs. These interactions have not been analysed based on the verification of other PAs. This possibly creates a lack of information about all interactions among PLCAs and other PAs which may exist in reality.

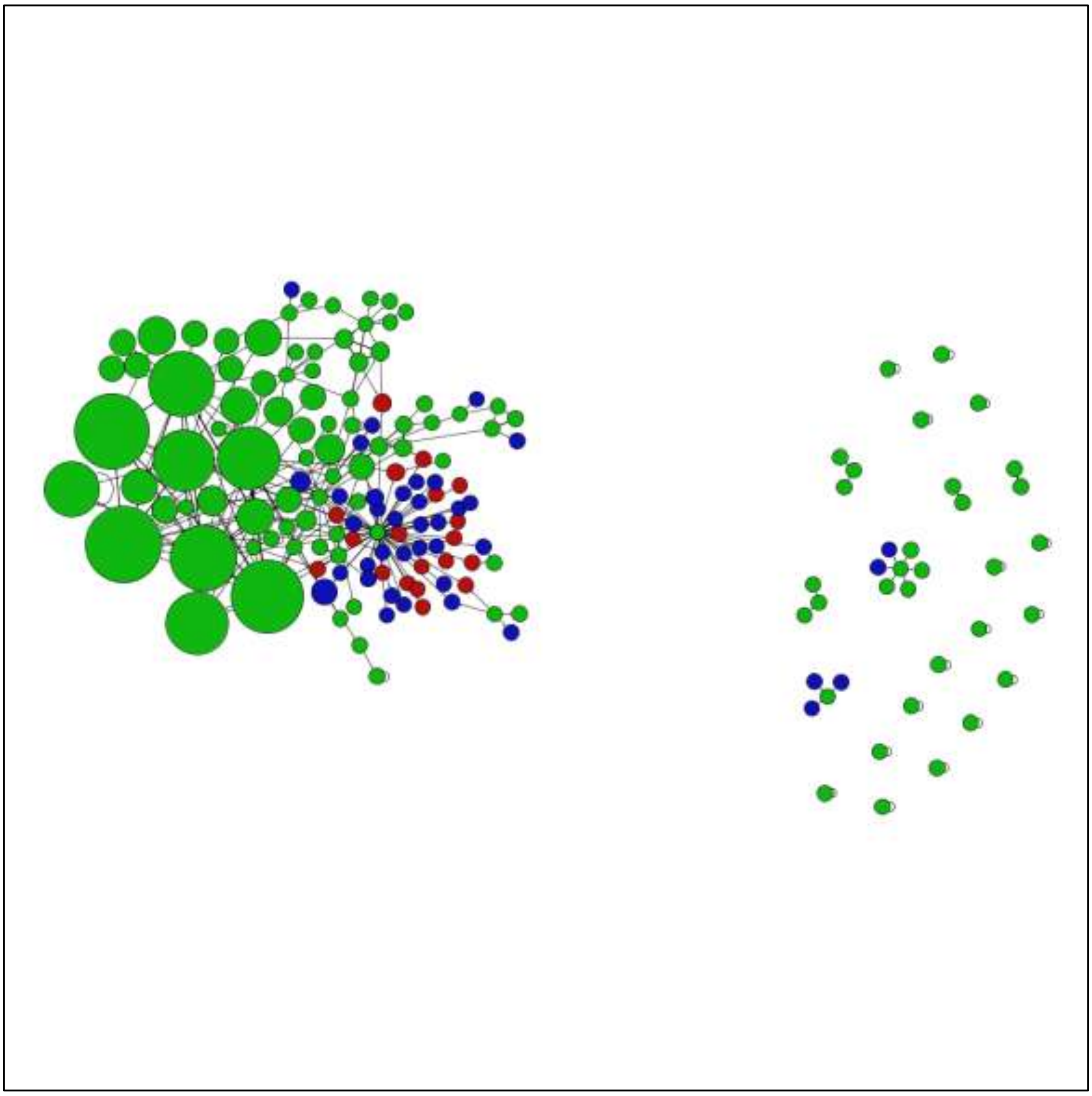


Figure 3: Total PA network in the Western Cape Province, weighted by eigenvector centrality, i.e. the largest green circle represent PLCAs which were best connected in the entire network, and to other important PAs. The size of the nodes represents the highest importance, the colours the different PA types: PLCAs are depicted in green, provincial PAs in blue, national parks in red. Visualized with Gephi

The total PA network was divided into 24 sub-graphs which were densely connected due to internal degree and centrality, i.e. formed clusters of interaction (Figure 4). Colours in the figure help to distinguish communities visually. Further assessment of the results showed, that most communities existed among PLCAs; only two individual PLCAs created distinct communities together with provincial and national PAs.

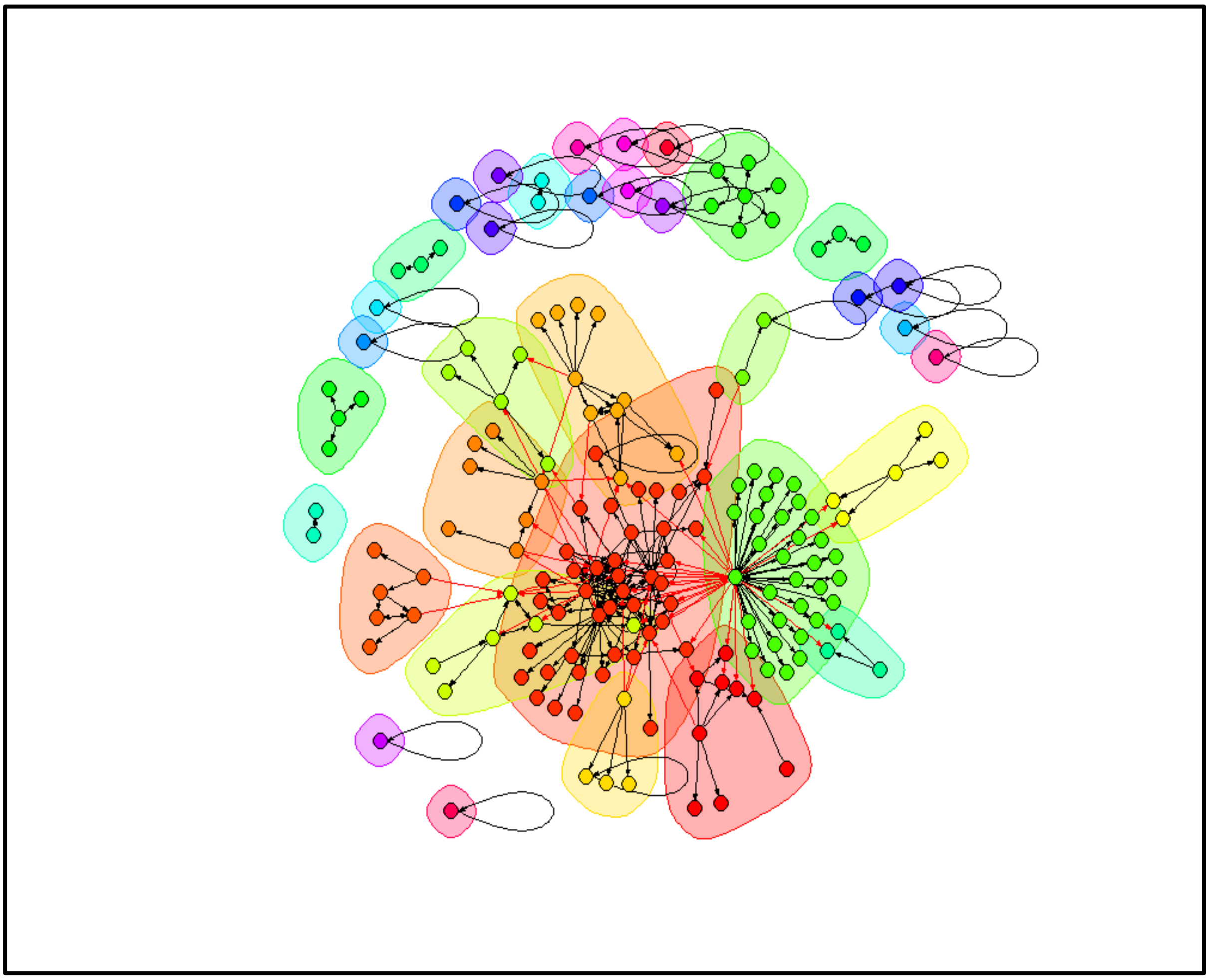


Figure 4: Total PA network in the Western Cape Province, with sub-graphs (i.e. interaction clusters) highlighted by different colour clouds. Black arrows represent connections between nodes; black loops represent lack of connections. Colours do not specifically refer to certain sub-graphs but rather help to distinguish all communities visually. Visualized with R

Community membership

Looking at the total PA network, most interactions existed at the same socio-political level. A total of 19 national parks and 39 provincial PAs occurred in the network but PLCAs mostly interacted with other PLCAs (189 interactions) and much less frequently with provincial PAs or national parks (83 interactions). Only one third (24 out of 70) of PLCAs maintained links to other PA types.

Game reserves interacted significantly more ($p < 0.001$) with other private game reserves instead of private habitat reserves (131 vs. 8 interactions). By contrast, habitat reserves maintained significantly more ($p < 0.001$) interactions with private game reserves (33 vs. 17 interactions).

With 78 nodes and 161 edges, the community of game reserves was smaller than the habitat reserve community (116 nodes and 133 edges). On average, game reserves had 4.1 links to other PAs whilst habitat reserves had only 2.3. The habitat reserve community had a smaller diameter (3) than the game reserve community (6) which means that information in the habitat reserve community could travel faster but not very far. This finding was also confirmed by the shorter average path length of habitat reserves when compared to game reserves (1.1 vs. 2.4)

The game reserve community showed a lower number of sub-graphs when compared to the habitat reserve community (10 vs. 19). The habitat reserve community was less well linked and showed more disconnected sub-graphs which also explained the small diameter and average path length (Figure 5). In total, 8 individual game reserves were unconnected; in the habitat reserve community this number was higher with 11 PLCAs not being connected at all.

Further assessment of results showed that at the level of governmental authority, only 3 national parks and 7 provincial PAs were part of the game reserve community. With 19 national parks and 35 provincial PAs the connection across levels was much stronger in the habitat reserve community.

Within the game reserve community another pattern evolved when assessing the centrality of nodes. Based on their higher centrality values, ten PLCAs appeared to be the most important for connecting the game reserve community. All these ten PLCAs kept Big 5-species on their properties. They appeared to have built a sub-network that was not influenced by location but rather by the topic of common interest.

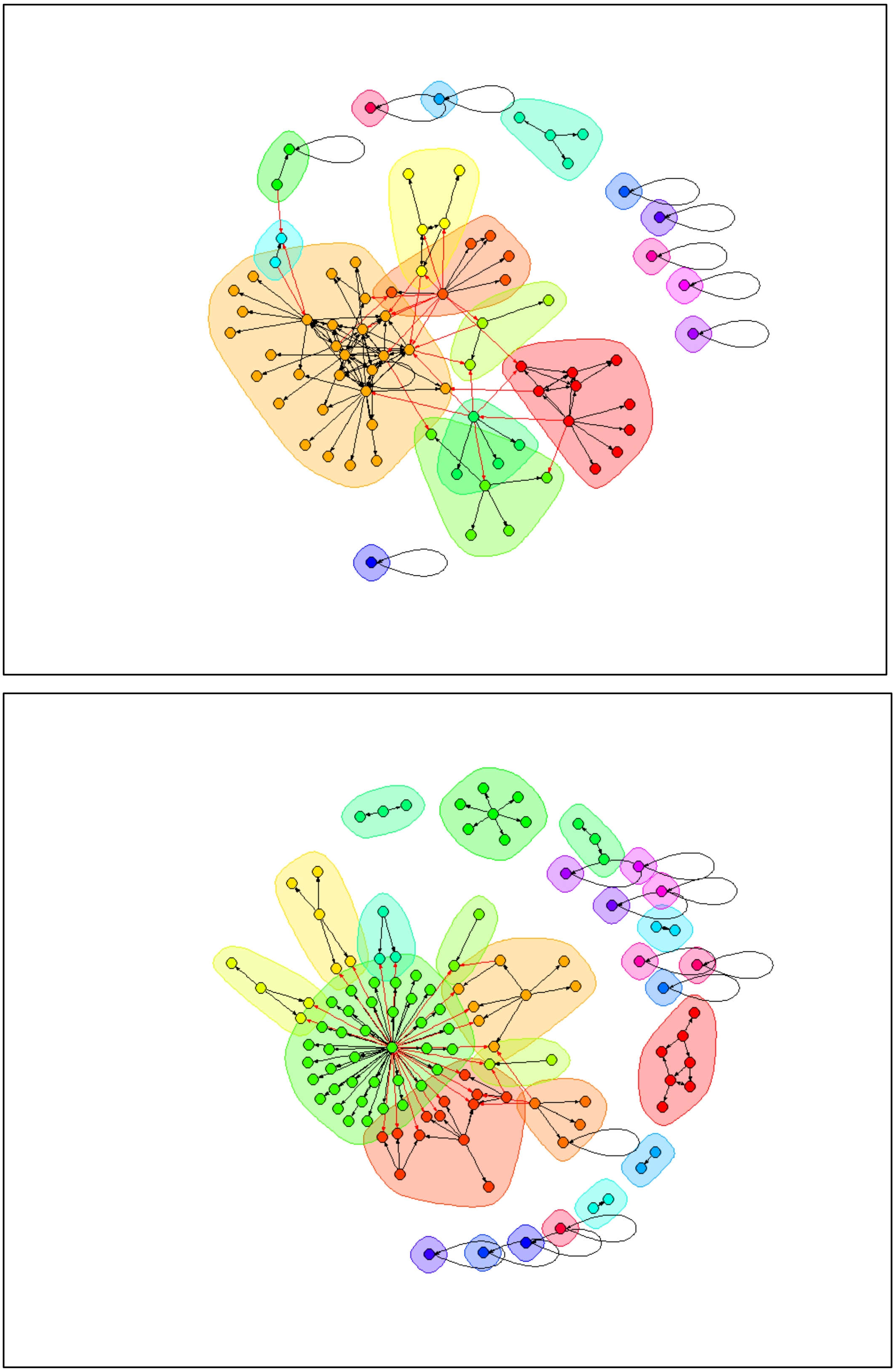


Figure 5: Total community of game reserves (top) and habitat reserves (bottom) to other PAs in the Western Cape Province, with sub-graphs (i.e. interaction clusters) highlighted by different colour clouds. Black arrows represent connections between nodes; black loops represent lack of connections. Visualized with R

4.3.2 Spatial Patterns

The analysis of average distances between connected versus unconnected PAs in the total network (Figure 7) showed a clear neighbourhood effect. The mean distance between connected PAs was significantly smaller (174km; $p < 0.001$, $t = 8.26$, $df = 12389$) than the mean distance between unconnected PAs (330km). PLCAs were therefore more likely to interact with other PAs in close proximity.

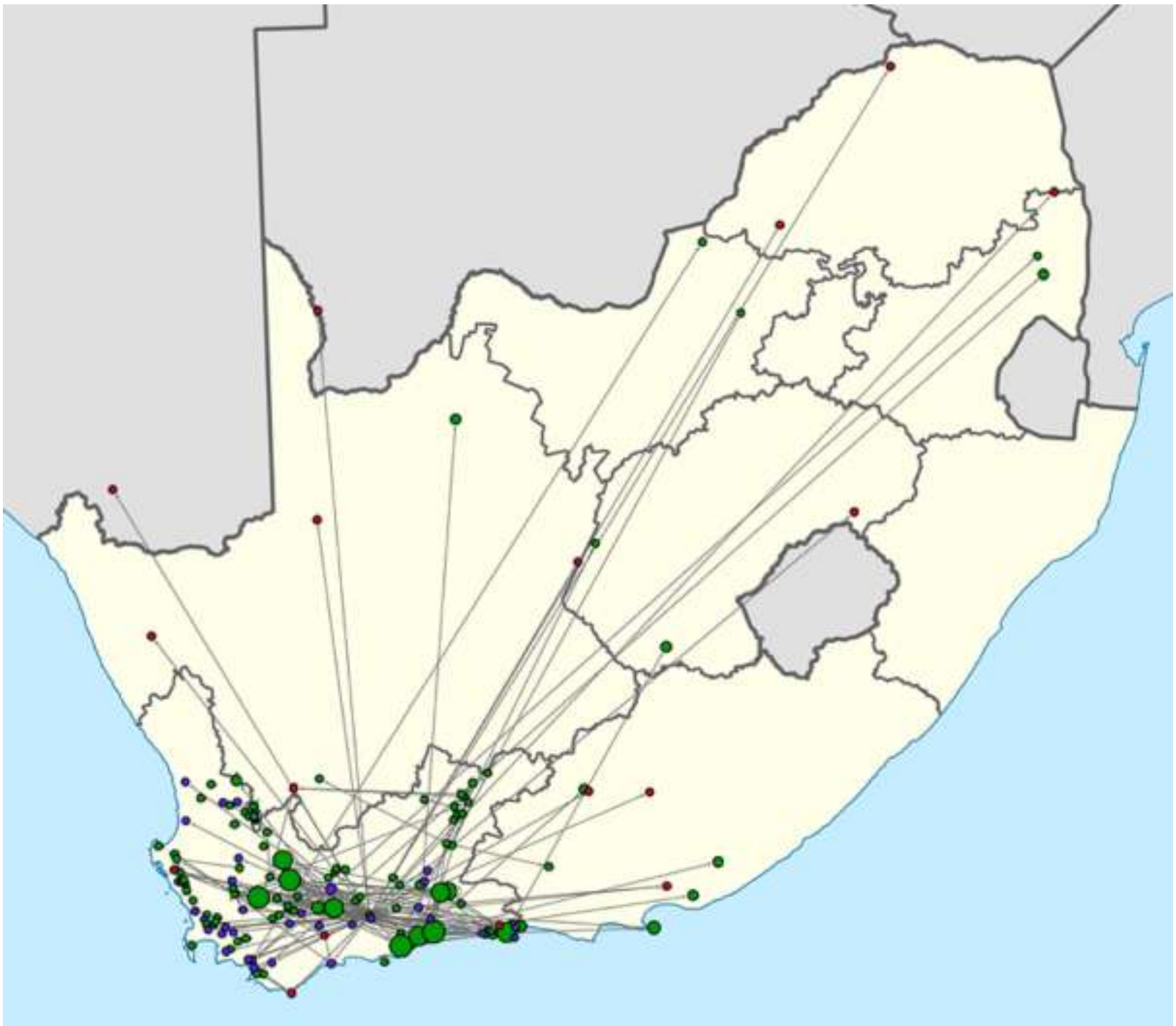


Figure 7: Spatial projection of the PA network across South Africa, weighted by eigenvector centrality (size of dots). PLCAs are depicted in green, national parks in red, provincial PAs in blue. Visualized with Gephi (map source: Frith 2010)

The same pattern emerged for both the game reserves community (connected = 155km, unconnected = 327, $p < 0.001$, $t = 7.12$, $df = 6016$) and the habitat reserves community (connected = 197km, unconnected = 332, $p < 0.001$, $t = 4.63$, $df = 6371$). This means that, regardless of the PLCA type, all PAs tended to interact with PAs in closer proximity rather than across long distances.

4.3.3 Interaction with Entities

Eight study participants did not have any interaction with external stakeholders (i.e. entities) and are excluded from the following analysis. The total interaction network of PLCAs with individual entities (i.e. stakeholders) consisted of 179 nodes (i.e. 62 PLCAs and 119 individual entities interacting with each other) and 303 edges (interactions). The graph had an average degree of 3.4. No sub-graphs existed; all nodes were connected with both the diameter and the average path length as 1. In a random graph of the same size the mean diameter would be 23 (standard error 3.35) and the mean average path length 7.8 (standard error = 0.6), which means that information in a random graph would travel much slower but further than in the real network.

Information about interactions to entities was only provided by PLCAs and thus directed in one direction. No information about interaction to PLCAs was obtained from entities. This possibly creates a lack of information about all interactions among entities and PLCAs which may exist in reality. The directedness of the graph limits the meaning of the two metrics (diameter and average path) in this case. The main hub of the entity interaction network according to both degree and centrality was CapeNature (Figure 8) which is the governmental conservation authority in the Western Cape Province. Other important entities were for example University of Cape Town, SANParks and WRSA.

The PLCA network with entity types contained 70 nodes (i.e. 62 PLCAs and 8 entity types) and 303 edges (interactions). The diameter and the average path length were again 1. Compared to the network with individual entities it had a higher degree of 8.3. Again there were no sub-graphs and all nodes were linked. The random graph in comparison had a mean diameter of 7 (standard error = 0.72) and a mean average path length of 3.1 (standard error = 0.05), meaning that information would traverse more slowly but would reach more nodes.

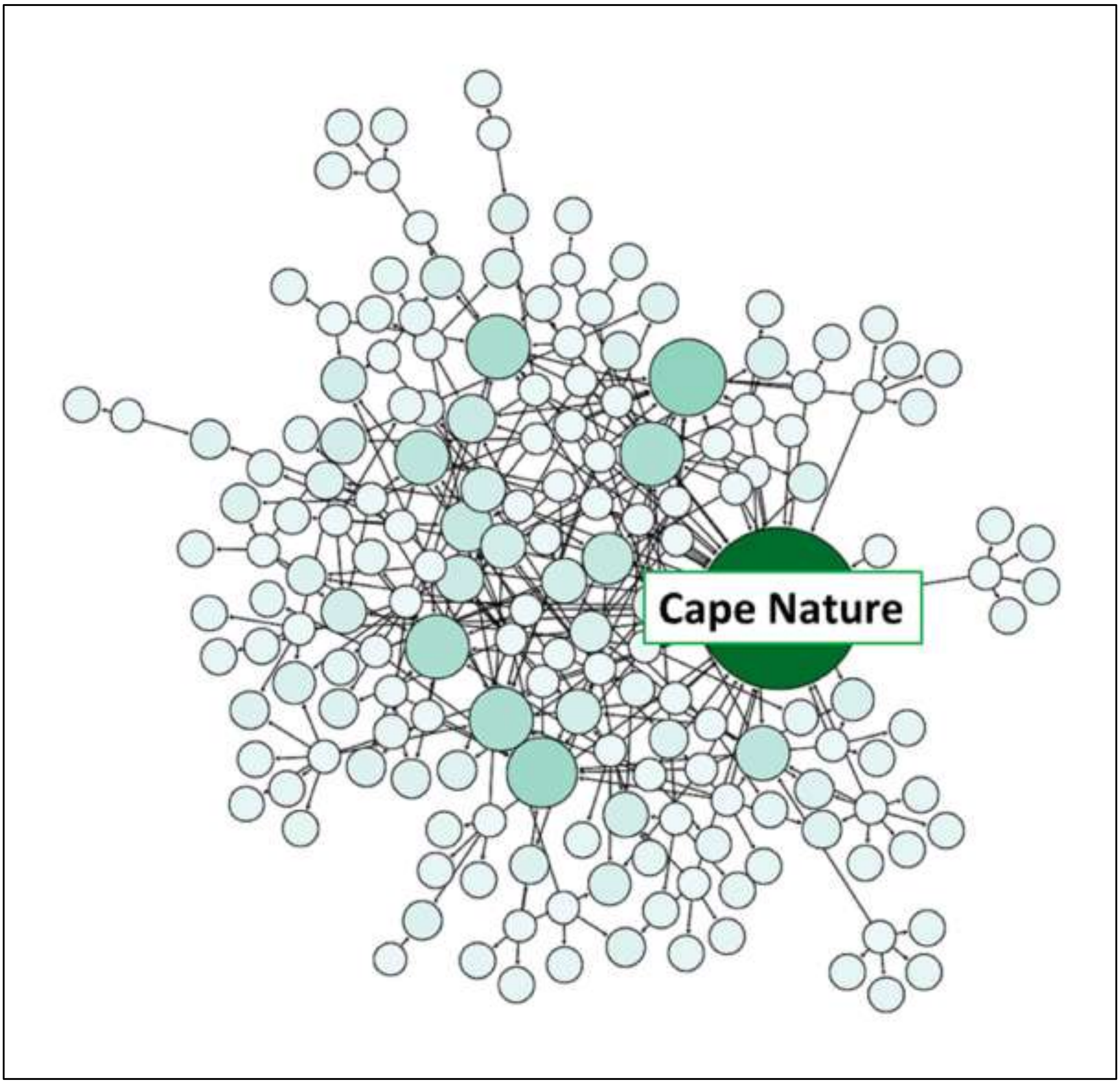


Figure 8: Total network of PLCAs interacting with 119 individual entities (such as schools, tourism bodies, companies) in the Western Cape Province, weighted by centrality (size of nodes). The colour shading represents the importance of nodes. Visualized with Gephi

The most important entity types for the total network were government/legislation, conservation/legislation and education/research which all carried similar weights (Figure 9). The local network, tourism/marketing and associations/societies built a second level of importance whereas wildlife/hunting/breeding and supplies/business were least important.

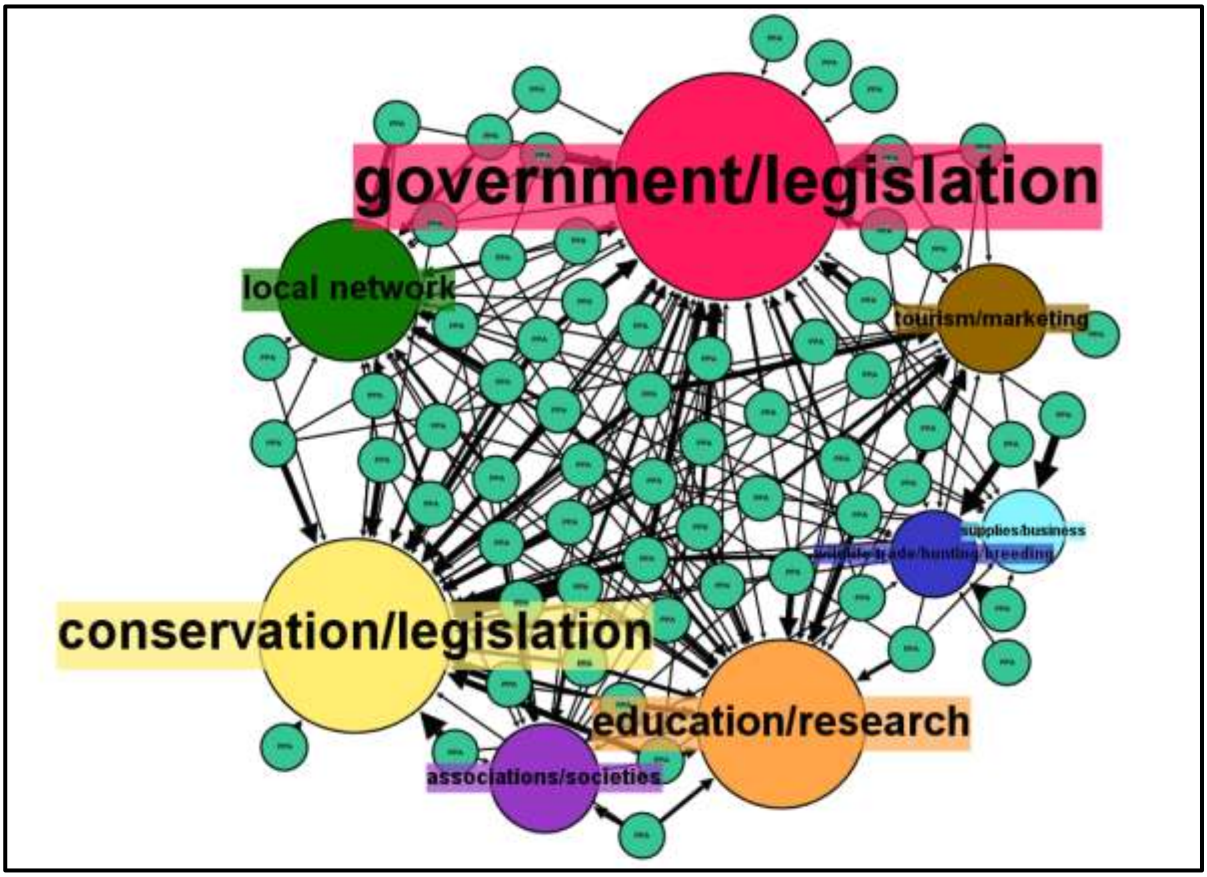


Figure 9: Total network of PLCAs interacting with 8 entity types in the Western Cape Province; weighted by centrality (size of nodes). Visualized in Gephi

By comparison, the communities of game or habitat reserves showed strong differences in the importance of entity types. When taking game reserves into consideration (Figure 10) the entities belonging to government/legislation were of substantial importance. The entity types of conservation/legislation and education/research closely followed in importance trailed by the entity types of local network, wildlife/hunting/breeding and tourism/marketing. Supplies/business and associations/societies were the least important entity types for game reserves.

For habitat reserves (Figure 11) conservation/legislation and government/legislation were almost equally important, followed by education/research, associations/societies and local network. Tourism/marketing, supplies/business and wildlife/hunting/breeding were the least important entity types.

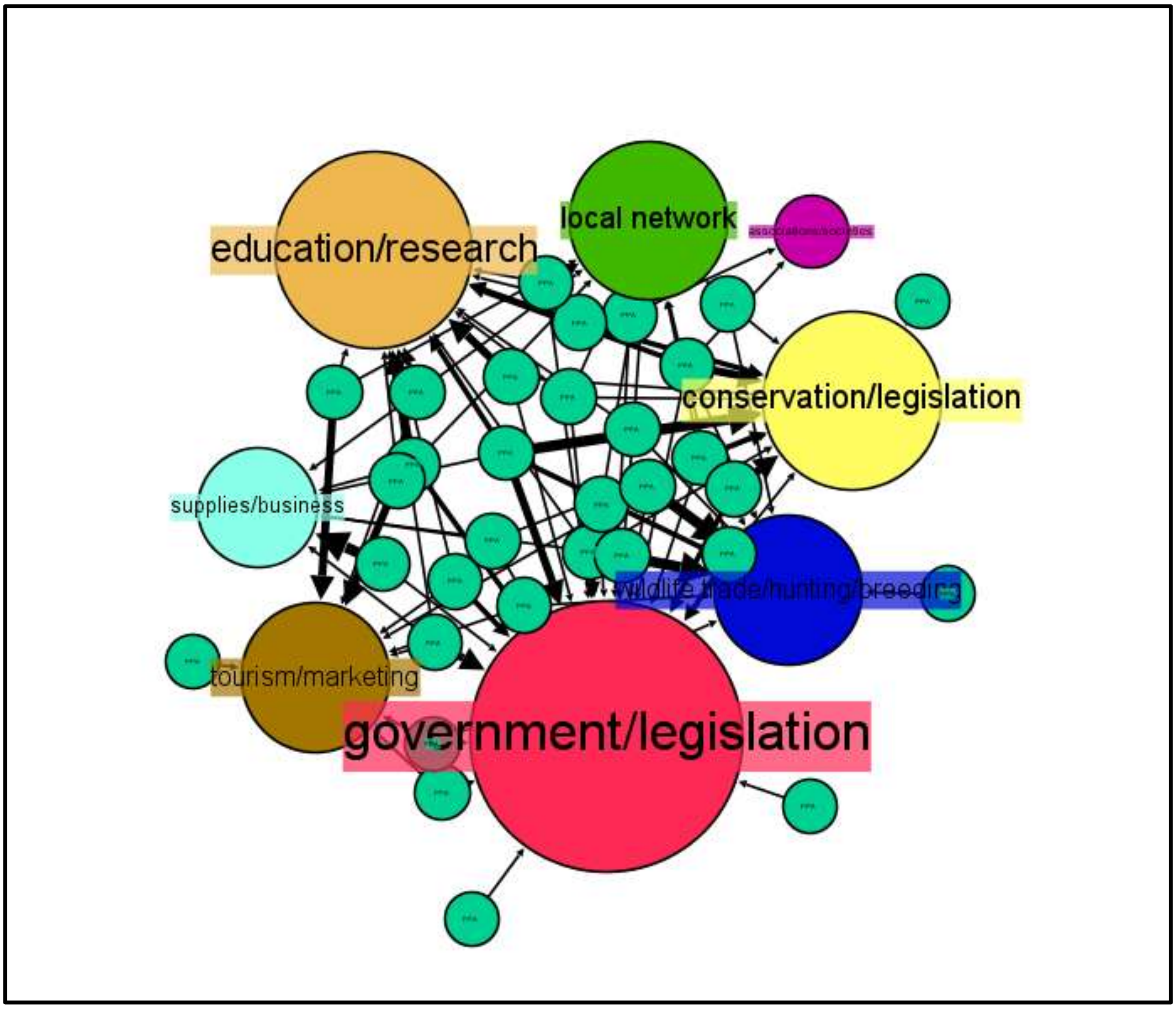


Figure 10: Game Reserve community with eight entity types in the Western Cape Province, weighted by centrality (size of nodes). Visualized in Gephi

Generally, the two communities were similar in size with 41 nodes each although the habitat reserves community were slightly better connected with 161 interactions and a degree of 7.9 in comparison to the game reserve network with 142 interactions and a degree of 6.9. Both communities had a diameter of 1 and an average path length of 1.

A random graph of game reserves would have a mean diameter of 7 (standard error = 0.82) and a mean average path length of 3.1 (standard error = 0.1), indicating that information would travel more slowly but further than in the real network. Similarly, a random graph of habitat reserves would have a mean diameter of 8 (standard error = 0.71) and a mean average path length of 2.7 (standard error = 0.06).

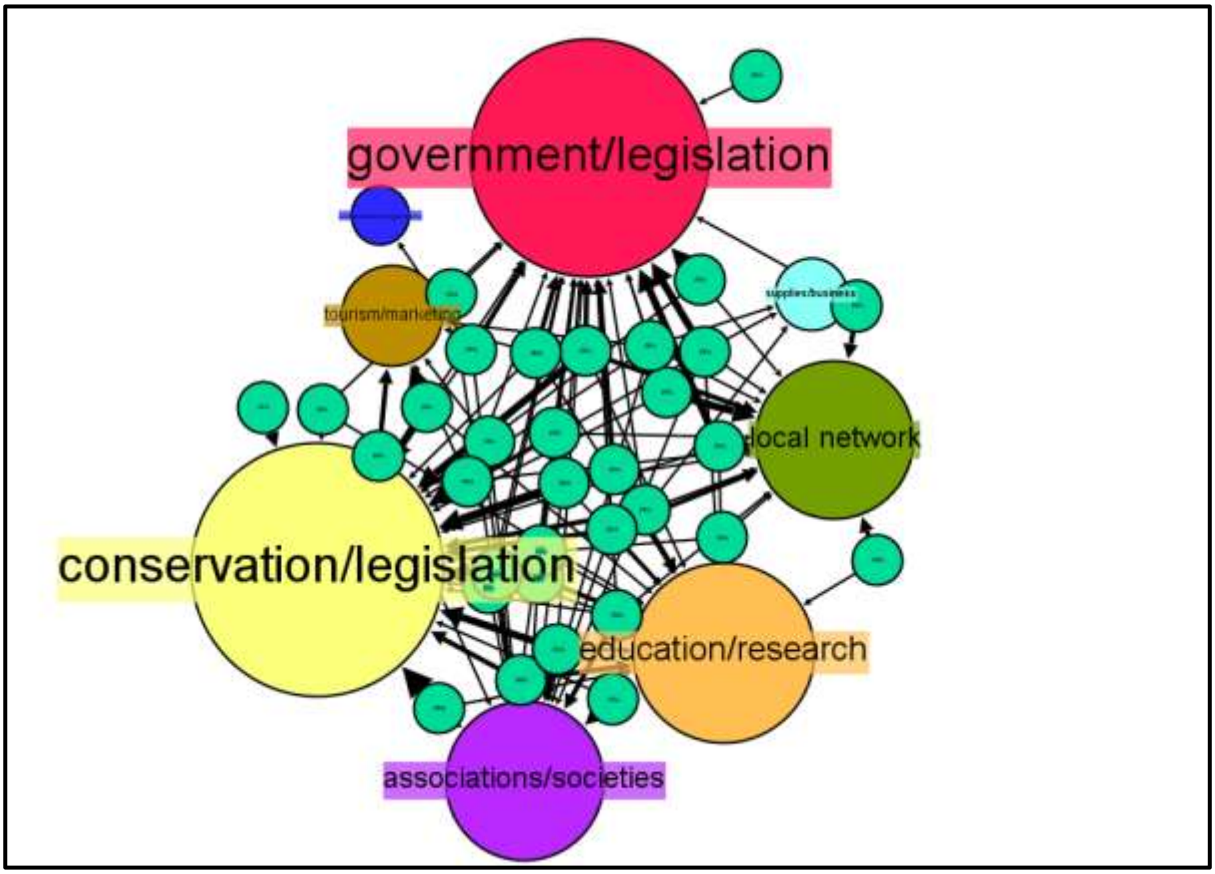


Figure 11: Habitat reserve community with eight entity types in the Western Cape Province, weighted by centrality (size of nodes). Visualized in Gephi

4.3.4 Types and Topics of Interaction

Generally, interactions of different types or topics were stated by study participants. Several of these interactions could take place with the same target PLCA, meaning that total numbers of interactions were higher than if only presence or absence of any interaction were considered.

Protected Area Network

Types of interaction

In the overall PLCA network with other PAs, most interactions were of socio-economic type (263) rather than ecological (125). Furthermore, interactions took place rather occasionally (217) than frequently (171). Again, when assessing the communities, game reserves had more socio-economic (143) than ecological interactions (101) and also collaborated more occasionally (167) than frequently (77). Habitat reserves showed the same trend of having more socio-economic relations (120 vs. 24 ecological) but did however interact with other PAs more frequently (95 vs. 49 occasional).

Topics of interaction

Looking at the topics of interaction among PAs, there were as a total of 1,052 interactions with 12 different topics taking place. One of these topics, “others”, captured a mix of uncommon interactions stated by individual PLCAs, such as wildlife trade or rehabilitation. Within the overall network the most important topics included knowledge transfer, wildlife and resource transfer. These were followed by research, education, tourism and marketing. Least important were the more legal and binding collaboration topics such as employment, legislation and finances (Figure 12).

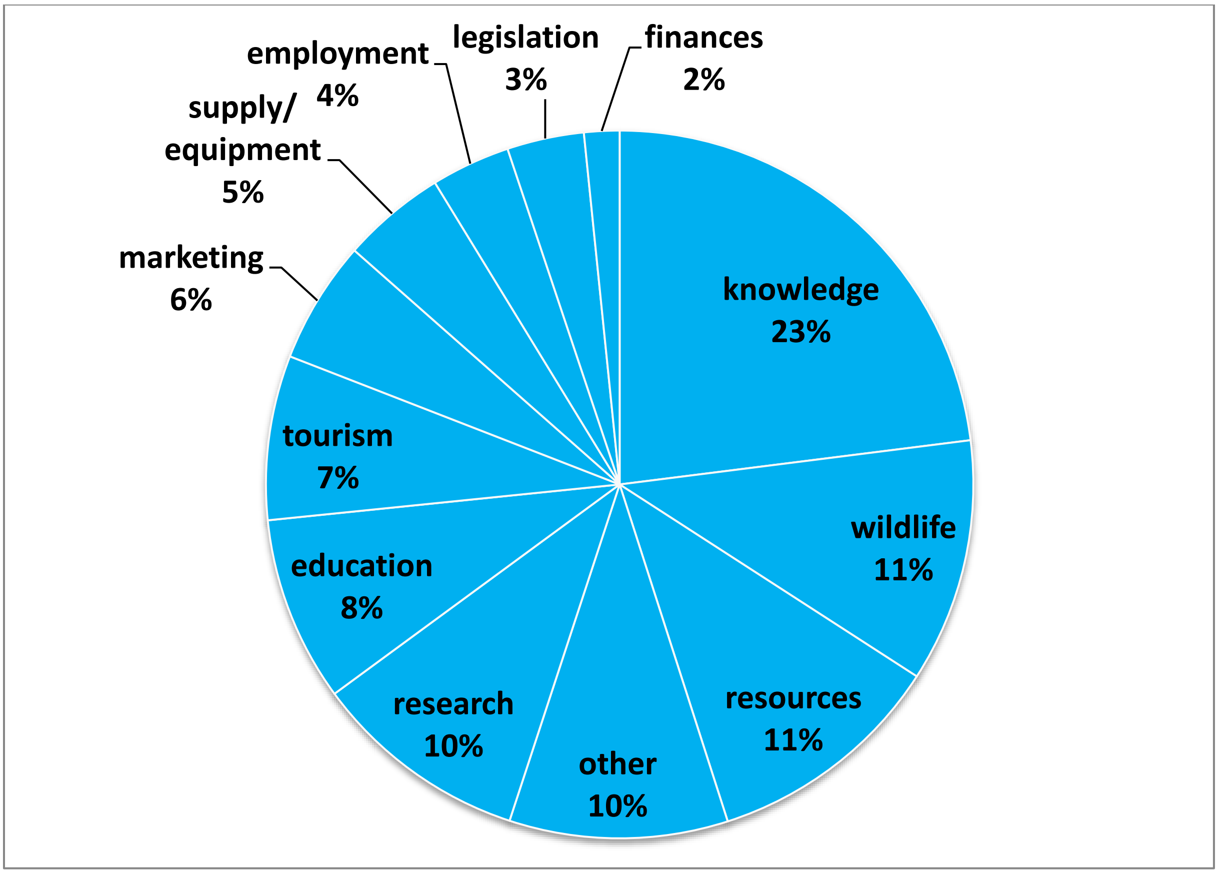
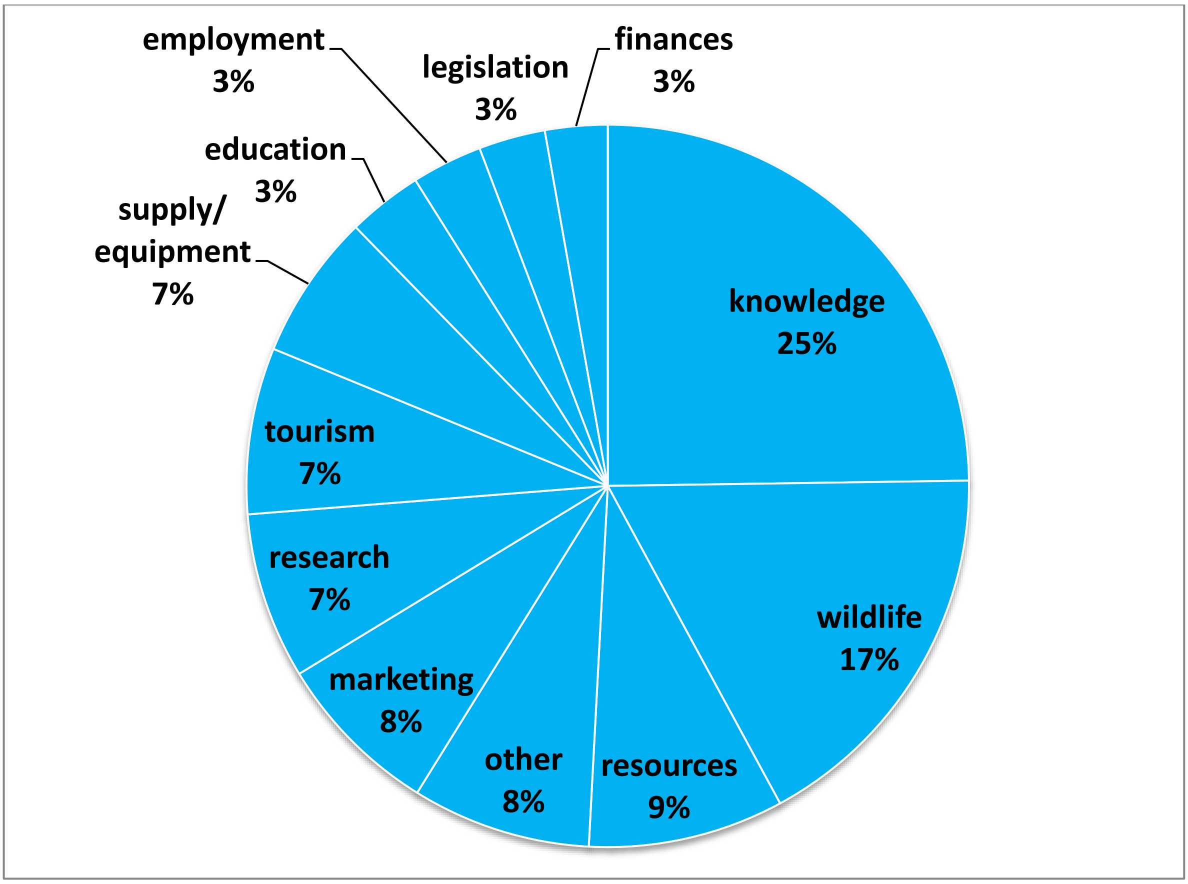


Figure 12: Topics of interactions in total PA network in the Western Cape Province, depicted as percentages

Within the communities of game reserves and entities there were 536 interactions in total which again tended to be infrequent (333 vs. 203). This trend was reversed for the habitat reserve community, where interactions were more frequent (392 vs. 122 occasional; 514 total). Two of the most important topics for both communities were knowledge and resource transfer. Wildfire together with marketing and research were additional important topic for game reserves whilst education and tourism were important for habitat reserves (Figure 13).



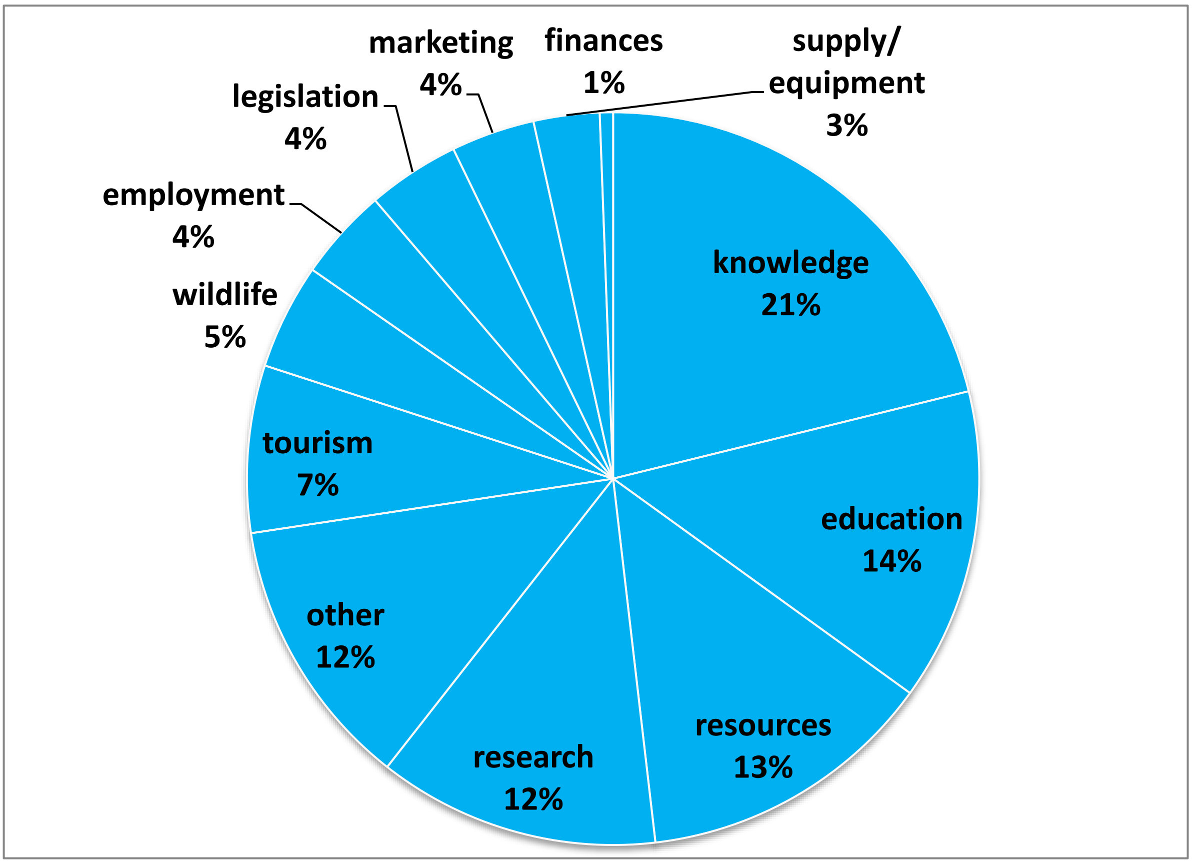


Figure 13: Topics of interactions in game reserves community (top) and habitat reserves community (bottom) in the Western Cape Province, depicted as percentages

Entity Network

Types of interaction

In the overall PLCA network with entities there were a total of 413 interactions taking place. These interactions were more frequent than occasional (240 vs. 173). Similar to the PA network, interactions tended to be more socio-economic than ecological in nature (293 vs. 120). Game reserves interacted more frequently with entities (117 vs. 87 occasional) and also in relation to more socio-economic rather than ecological topics (137 vs. 68; 205 total). The same trends transpired for interactions between habitat reserves and entities: interactions were more frequent (117 vs. 82 occasional) and socio-economic (150 vs. 49 ecological; 199 total).

Topics of interaction

For the 12 different topics of interaction the overall PLCA network with entities consisted of 1,114 interactions. The most important topics were knowledge transfer, research and wildlife (Figure 14). Game reserves had a total of 534 interactions with entities. The three most important topics mirrored that of the overall network. Important topics for game reserves also included legislation, education and supply/equipment (Figure 15). For habitat reserves, this rating differed; the 585 documented interactions were more strongly related to topics of research, legislation, education, wildlife and tourism (Figure 15).

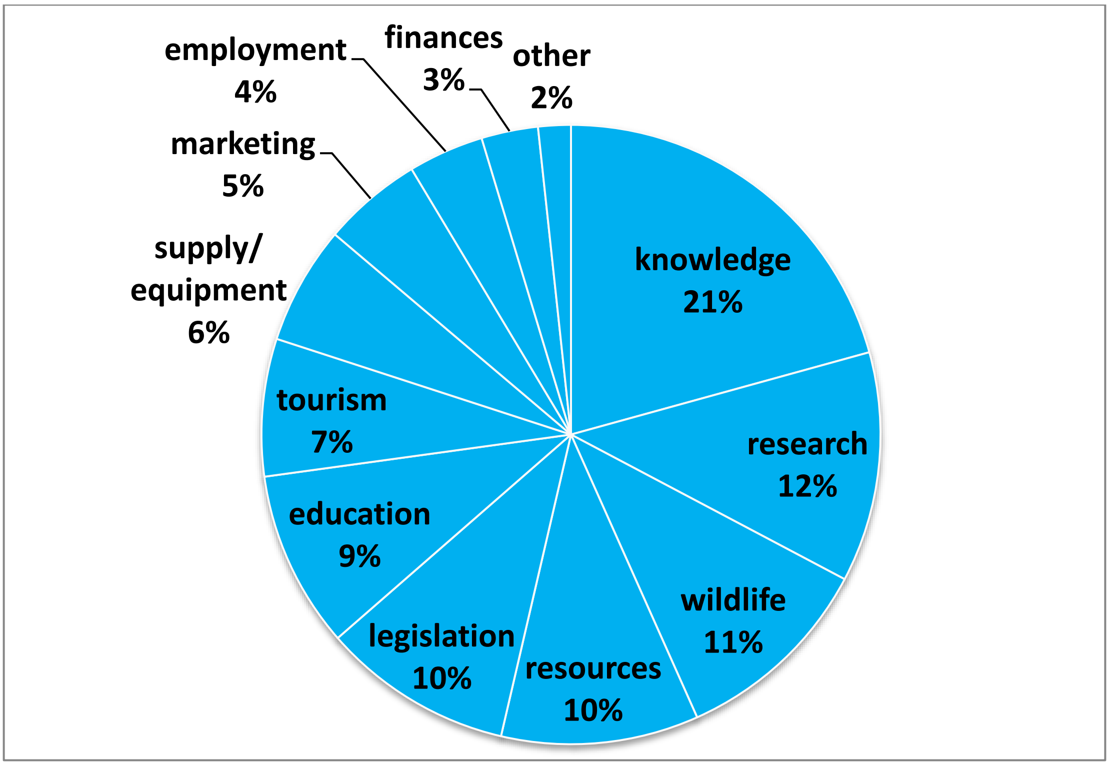
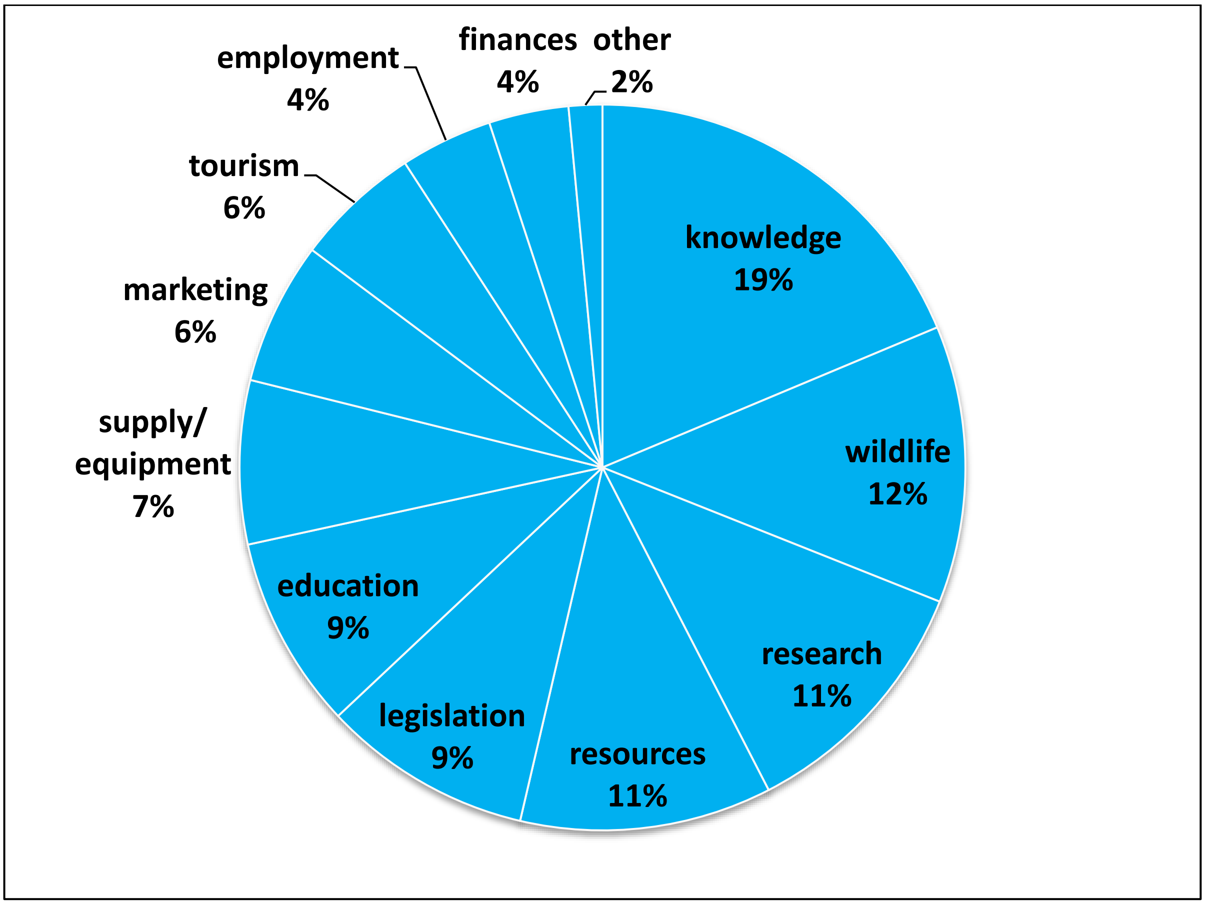


Figure 14: Topics of interactions in total network: PLCAs interacting with entities in the Western Cape Province, depicted as percentages



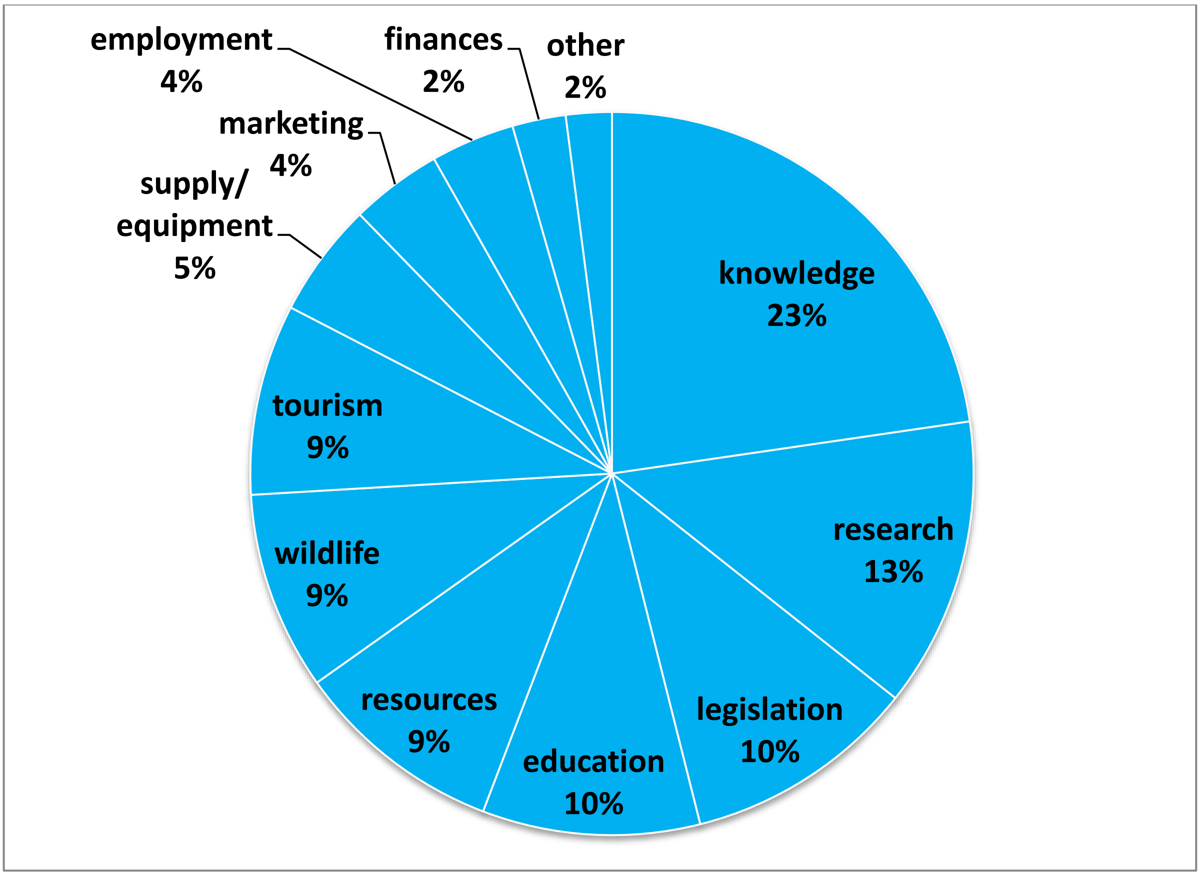


Figure15: Topics of interaction between game reserves and entities (top) and habitat reserves and entities (bottom) in the Western Cape Province, depicted as percentages

Conditions of Interaction among PLCAs

Owners and managers stated two main conditions as most important for the interaction with other PLCAs (Figure 16). These conditions were having a positive relationship to the collaborating PLCA and interacting with each other in close proximity. A third important condition was to have similar ecological conditions on the property, followed by being ecologically connected. The first condition represents social connectivity, whereas the second and third conditions represent spatial connectivity.

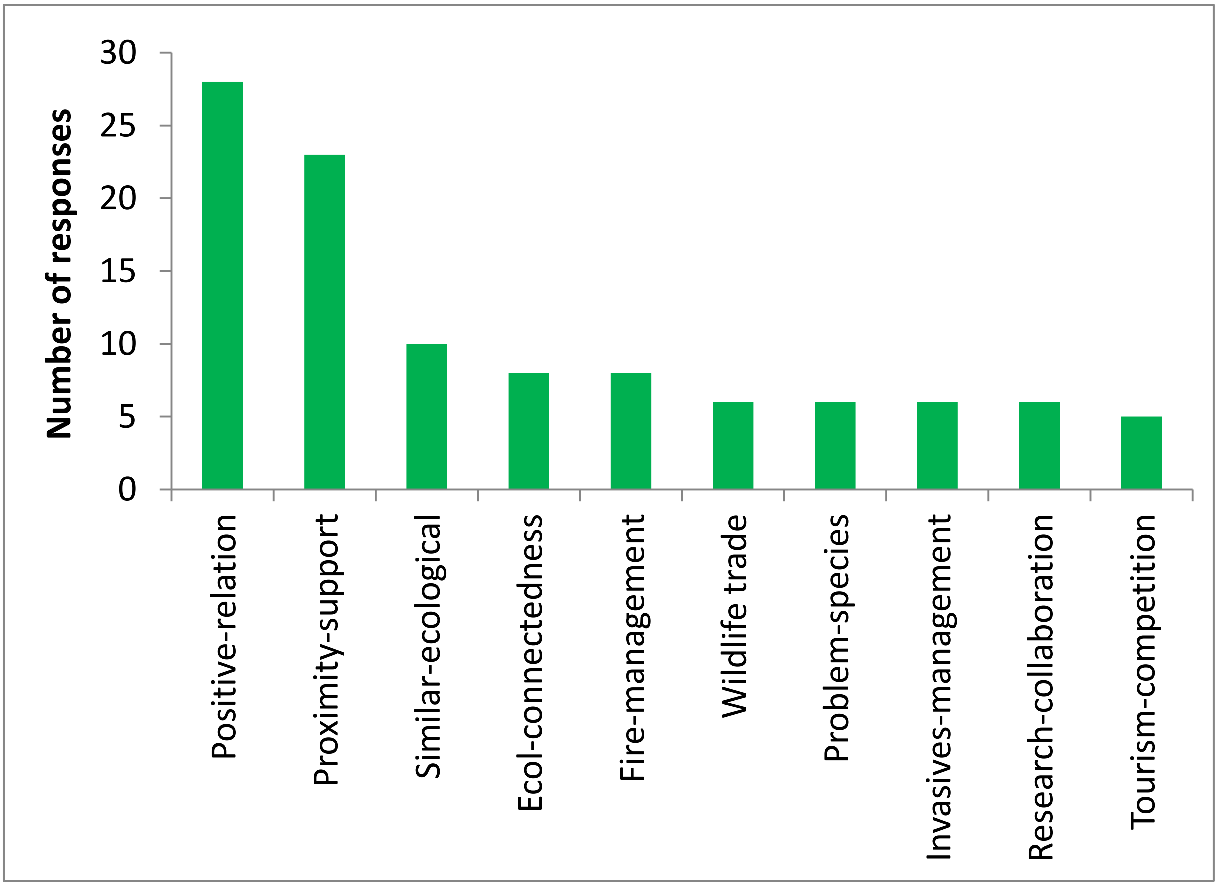


Figure 16: Most important conditions for interaction among PLCAs in the Western Cape Province, rated as 5 on a scale from 1 (not relevant) to 5 (very important) by landowners and managers. Depicted are conditions which were mentioned as most important by more than 5 PLCAs

4.4 Discussion

PLCA owners and managers in the Western Cape Province interact with one another about a variety of issues, and to a lesser extent with managers of both provincial reserves and national parks. Maciejewski & Cumming (2015), focusing on provincial and national parks, also found important interactions (such as knowledge or resource sharing) between the different parties involved in conservation. My results, however, highlight that PLCAs currently function as a distinct sub-group within the broader conservation domain, with little overall coordination in their management objectives. Interactions took place mainly among PLCAs, with a lack of collaboration across institutional levels, and PLCA networks generally had low degrees, short path lengths and many communities and thus represented scale-free networks. By comparison to random graphs, the PLCA network was significantly less connected than expected. Resources could travel quickly between the few linked PAs but would not be able to easily traverse across entire networks to reach many PAs. In interviews, many participants stated that competition (or fear thereof) plays an important role in their actions, providing a potentially important isolating mechanism. Similar effects, with spatial proximity causing both positive neighbourhood effects as well as competition, were found in the USA (Albers et al. 2008) where PLCAs were clustered together in space as well as influenced by the location of governmental PAs. In California, PLCAs appeared to be clustered around (attracted to) statutory PAs whereas in Illinois and Massachusetts they showed a trend of repulsion. Spatial location would therefore play a vital role for site selection of statutory PAs to be implemented in the future and the type of effect (i.e. collaboration or competition) caused.

Despite their relative isolation, most PLCAs in the Western Cape Province nonetheless participated in some collaborative interaction. Interaction in PLC networks in the Western Cape Province was determined both by neighbourhood effects and membership in communities. Significant neighbourhood effects, i.e. interaction in close proximities, existed within the total PA network and for both communities of game and habitat reserves. The PLCA typology, which was identified in Chapter 3, played a vital role for relationships of PLCAs. Membership in non-spatial communities (i.e. interacting focused on common topics of interest) was only found in the game reserve community where PLCAs with existing Big5-species transpired as a main hub. Habitat reserves interacted preferentially in spatial local clusters rather than venture outside close proximity. Conditions of interactions as stated by the study participants matched the statistical results of neighbourhood effects where important influences came from positive relations to collaborators, proximity in space and similar ecological conditions.

With these findings, I could verify the second alternative hypothesis, which stated that a combination of both positive neighbourhood effects and membership in communities would determine the structure and functioning of PLC networks. Game reserves interacted more frequently with other game reserves. This pattern may evolve due to the stocking of appealing wildlife or enhanced tourism activities. These, in turn, might lead to a need for enriched collaboration, for example in terms of knowledge about management practices or wildlife translocation. Habitat reserves, contrarily, interacted more with game reserves than habitat reserves. This is an interesting finding. It might be caused by the potentially high prestige of game reserves, so that habitat reserves rate such interactions as more important. Alternatively, habitat reserves might seek to collaborate with game reserves to profit from their expertise and connections, since game reserves are often better interlinked and more active in tourism.

Topics of collaboration among PLCAs also differed according to the PLCA typology. Game reserves related more with respect to wildlife, marketing and research topics. Habitat reserves collaborated more about education and tourism. In the entity networks a similar trend occurred where game reserves had more interaction concerning wildlife and legislation whereas habitat reserves had more interaction concerning research and education. Generally, game reserves appeared to be occupied with internal issues about their wildlife whereas habitat reserves exhibited openness towards outreach.

CapeNature, as the provincial conservation authority, was the most important entity in the overall interaction network. The institution is responsible for regional legislation and plays a major role in knowledge transfer, enforcement of regulations and support through for example the Stewardship Programme (Cape Nature 2015).

Generally, my assessment of socio-economic connectivity of conservation networks in the Western Cape Province highlights that potentially value-adding forms of collaboration, such as research, wildlife trade or sharing the burden of controlling invasive species, are under-exploited. PLC is increasingly perceived as supplementary solution for maintaining and expanding the global conservation estate. For example in Australia, PLCAs as part of multi-tenure networks contributed importantly to the connectivity of statutory PAs. Here, statutory conservation networks were shown to have long distances between PAs. Considering PLCAs in these networks strongly lowered average distances and thus increased overall potential linkages (Fitzsimons & Wescott 2008a). Close spatial proximity of PAs will not inevitably lead to negative competition, which appears to be one of the main barriers to information exchange as stated by my study participants. Clusters of PAs could potentially increase their revenue by actively collaborating to attract more visitors by providing a greater range of facilities and activities (De Vos et al. 2016b).

While theory suggests that having a diversity of management strategies may be more resilient (Westley et al. 2002; Norberg et al. 2008), this diversity is unlikely to contribute to desired resilience of PLCAs if successful innovations and new knowledge are not shared. Since the majority of research is undertaken in statutory PAs, it also seems problematic that private land conservation managers do not interact more frequently and more formally with the managers of statutory PA. This is highly relevant because networks change over time which causes a need for understanding their dynamics (Lauber et al. 2011). In multifunctional, human-dominated landscapes a coherent large-scale spatial structure of ecosystems is important for conservation (Opdam et al. 2006). Network theory and knowledge provide the framework to design such structures. Networks are dynamic but do not lose their conservation potential while changing and therefore contribute to both PA persistence and development. Furthermore, networks contribute to stakeholder decision making and to focusing on effective spatial scales. In Sweden, for example, network analysis and subsequent knowledge sharing and implementation was useful because landscape fragmentation was not yet considered enough in conservation planning and no analytical methods for assessing connectivity were used in practice (Bergsten & Zetterberg 2013). Network analysis and knowledge sharing methods were, however, identified by practitioners as helpful to "communicate the meaning and implications of connectivity to other actors in the planning process and to better assess the importance of certain habitats affected by detailed plans". Similarly, Bodin & Crona (2009) argued that it is a research and governance challenge to assess and identify favorable network characteristics and their effective mix in order to obtain positive governance effects and avoid undesired effects in natural resource governance.

Fitzsimons & Wescott (2005) in Australia found that within three multi-tenure conservation networks the total area protected varied strongly although the networks had a similar number of components. The networks, however, showed few similarities with respect to tenure and protection mechanisms. The authors argue that historical drivers (remaining vegetation, land ownership and degree of subdivision) and contemporary drivers (landowner willingness for participation and objectives) are likely to influence network composition. In relation to my findings, the named historical drivers are manifested in the landscape and can thus also be perceived as spatial factors. In order to better understand the operation of conservation networks and to improve conservation planning across landscapes, multi-tenure networks have to be assessed in terms of their dynamics (physical and social) and their evolution (Fitzsimons & Wescott 2005).

Building desired resilience through managing connectivity (Biggs et al. 2015) for PAs can be achieved at different scales. Considering sub-systems and influences across scales is important because there are different arenas where decisions are taken which might affect PAs. There is a need to align multiple sub-systems and to coordinate responses to common threats (Cumming et al. 2015b). In the Western Cape Province, at the individual PLCA scale, my findings identified the importance of close proximity and local clusters of interaction. This indicates that there is potential to focus on an enhancement and improvement of collaboration within regions, such as dropping property fences or establishing conservancies for collaborative management. A more effective set of governmental economic incentives and programmes could also help to safeguard private land conservation efforts: for example, tax rebates, the possibility of some kind of hardship fund to facilitate PLCA persistence through economic downturns or changes in ownership, and greater expertise sharing by skilled governmental and university-based personnel. At the regional scale, my findings identified a lack of connectivity across scales where PLCAs hardly connected with governmental PAs. There is high potential to enhance and improve linkages between hierarchical levels, across local clusters and different stakeholders. At the national scale and beyond, new and flexible strategies for conservation have to be implemented which allow for polycentric governance and diverse tenure types of PAs. This could be greatly facilitated by bridging organizations that connect different stakeholders and develop the learning potential that is dormant in the current network (e.g., Vance-Borland & Holley 2011).

Chapter 5: Spatial Variation in Ecotourism Drivers explains Visitation Rates to Private Land Conservation Areas

5.1 Introduction

Protected areas (PAs) are a vital tool in conservation and are essential for maintaining ecological resilience and ecosystem functioning (Tilman & Downing 1994). Their role, however, is not only linked to the conservation of biodiversity by protecting species and their habitats. From the perspective of the 'nature for people' paradigm, focus is put on ecological economics and the benefits that people obtain from nature (Mace 2014). Ecosystems provide many tangible (e.g. generation of economic revenue) and intangible (e.g. recreation) benefits to society which directly and indirectly support human well-being, as recognized by international policy instruments such as the Convention on Biological Diversity with Aichi target 11, the Millennium Ecosystem Assessment and the sustainable development goals (SDGs) (Millennium Ecosystem Assessment 2005; CBD Secretariat 2015b; United Nations 2015). These benefits are provided by ecosystems but co-produced with people and understanding these dynamics can provide insight about social-ecological interactions and system resilience (Mace et al. 2012; Reyers et al. 2013). PAs, in this context, can be perceived as institutions which link social and ecological systems by providing diverse benefits to society (Kettunen & ten Brink 2013).

A widely applied framework for understanding and quantifying benefits provided by ecosystems (and thus by PAs) is that of ecosystem services. The ecosystem services framework facilitates a better understanding of the links between ecological structures and processes and their utilisation and valuation (Daily 1997; Carpenter et al. 2009; Costanza et al. 2014; Guerry et al. 2015). Ecosystem services thereby provide a bridge between conservation and economics (Daniel et al. 2012). Three major categories of ecosystem services can be distinguished: 1) provisioning services, 2) regulating and supporting services and 4) cultural services (Haines-Young & Potschin 2013). Cultural services refer to non-material benefits and are the most poorly understood and hardest to quantify because it is difficult to place consistent values on them (Millennium Ecosystem Assessment 2005; van Jaarsveld et al. 2005; Hernández-Morcillo et al. 2013) (Millennium Ecosystem Assessment 2005). The Millennium Ecosystem Assessment (2005) defines cultural services as including the categories 'spiritual and religious', 'aesthetic', 'inspirational', 'sense of place', 'cultural heritage', 'recreation and ecotourism', and 'educational'. More recently, the Common International Classification of Ecosystem Services (CICES) has grouped cultural services into 'physical and experiential interactions', 'intellectual and representational interactions', 'spiritual and/or emblematic services' and 'other cultural outputs' (Haines-Young & Potschin 2013). Examples of these categories as experienced in PAs are (amongst many others) the pleasure of watching and interacting with wildlife, outdoor activities (e.g., hiking and canoeing), and scenic beauty (Paloniemi & Tikka 2008; Di Minin et al. 2013).

Ecosystem services are often considered occurring in bundles (e.g. Raudsepp-Hearne et al. 2010; Martín-López et al. 2012) either through co-provisioning (one ecosystem provides several benefits) or co-dependence (one benefits is dependent on another one provided) (Bennett et al. 2009), however, a third approach is evaluating bundles based on the preferences of users which is vital regarding cultural ecosystem services (Ament et al. 2016). Cultural values and the perceived benefits to society provided by PAs have motivated the protection of ecosystems, their integration into management can strengthen conservation efforts and cultural services are important for the sustainability of PAs (Infield 2001; Daniel et al. 2012; Reyers et al. 2012). Established facilities and the natural context of PAs allow visitors to access non-material benefits from activities and conditions, such as game viewing or remoteness from everyday life. Ecotourism can thus provide a proxy for the utilisation and valuation of cultural ecosystem services provided to societies as being accessed by PA visitors and users. It represents, via visitation rates and generated revenues, one of the few readily quantifiable measures of cultural ecosystem services. In many cases, maintaining and expanding PAs is dependent on costs (e.g. salaries, fencing) that have to be compensated for. Different strategies for financing these costs exist for different PA types. In many countries, national and provincial PAs, as managed by mandating authorities, derive important portions of their income from external governmental funds and do not completely depend on internal income, such as the South African National Parks (SANParks 2014). However, in most developing countries huge shortfalls in funding of protected areas resulting in insufficient management has been identified, although varying from country to country, and mobilizing new resources is urgent such as in Latin America and the Caribbean (Bruner et al. 2004; Bovarnick, A. et al. 2010). The context is very different for Private Land Conservation (PLC) which, in most cases, depends entirely on internal income generated on the property or by the landowner. Only a few external income sources exist for PLC, for example if Private Land Conservation Areas (PLCAs) receive governmental incentives such as a tax rebate or non-governmental support such as funding from private donors (e.g. Paulich 2010). Revenue derived from ecotourism (i.e. the provision of cultural services to visitors and users) can be an essential source of income for PLCAs to support conservation and management efforts, thus ensuring their future persistence (e.g., Lindsey et al. 2007). In other words, conservation costs can be covered through PLCA visitors paying for the provision of cultural services.

Since revenue from ecotourism is important for the economic viability of PLCAs, it is highly relevant to understand and quantify the supply of cultural services but also to assess their demand, utilisation and valuation (Reyers et al. 2013). Trade-offs and synergies between bundles of services and individual services can evolve and affect decisions in conservation and management contexts (Wolff et al. 2015). Visitation rates are a potential measure for understanding this supply and demand in PLCAs as they represent an easily quantifiable metric that can be used as a 'willingness-to-pay' measure (Chase et al. 1998; Khan 2004; Alpízar 2006; Ellingson & Seidl 2007). Assessing the drivers of visitation provides insight into potential options for maintaining and enhancing ecotourism, and thus the generation of economic revenue, to PLCAs. This insight into visitation applied to ensure and enhance ecotourism thus represents a source of continuity for PLCAs.

Little is known about the dynamics of ecotourism drivers within South African PLCAs despite it being a potential source of continuity with regards to maintaining PLCA identity and ensuring desired resilience. Ecotourism in South Africa and generally is a topic of controversy, however, impacts vary strongly with geographical location and the research on ecotourism is imbalanced and fragmented (Doan 2000; Weaver & Lawton 2007). On the positive side, it offers the potential of poverty reduction with local economic development, opportunities to implement pro-poor tourism and community-based natural resource management with beneficial impacts on local livelihoods (Spenceley et al. 2002; Rogerson 2006; Spenceley & Goodwin 2007; Spenceley & Meyer 2012b). Further, it can provide positive outcomes for biodiversity protection such as for endangered species (e.g. Lindsey et al. 2005). On the negative side, ecotourism in PLCAs and ecotourism in general has been criticized having many questionable impacts on society and the environment, such as increased water usage, informal development, habitat clearing, erosion or wildlife harassment (Spenceley et al. 2002, 2015). There appears to often exist a 'use-conservation gap' in protected areas which needs to be addressed in order to link the sustainability of natural and cultural resources (Jamal & Stronza 2009). Buckley (2003) discussed the approach of evaluating environmental inputs (the attraction of a destination) and environmental outputs (the net costs and benefits to the environment) of an ecotourism enterprise. The approach urges that on the output side a positive triple-bottom-line (referring to the assessment of environmental, social and financial costs and benefits) needs to be achieved for each enterprise.

Generally, visitors and users of PAs are influenced by push and pull factors determining their destination and consumption choices and their valuation of benefits provided (Kim et al. 2003). Push factors refer to the motivation and context of visitors travelling, pull factors refer to the desirability of a destination determined by the place utility. Thus, both internal and external factors are likely to influence visitation rates in PLCAs. Visitors may have different attitudes, backgrounds and belief systems and people make decisions based on what they would like to see or experience (Neuvonen et al. 2010; Martín-López et al. 2012). While ecological features of a PLCA are important in attracting people, for example, to enjoy game viewing or hiking in a natural environment (Dramstad et al. 2006), the context in which a PA is embedded, as well as features of convenience inside a PA (e.g. accommodation), can also strongly influence a visitor's choice about where to spend money and time as they do not only look for good ecological features (Seddighi & Theocharous 2002; Puustinen et al. 2009). This means that factors of ecology, location, infrastructure, discoverability and affordability may be underlying drivers of the utilisation and valuation of cultural services in PLC. All potential drivers show heterogeneity in space and this creates spatial variation on PLC ecotourism. Furthermore, potential drivers do not occur in isolation, meaning that a combination of factors may play an important role.

South Africa offers a potentially insightful case for understanding the relevance of PLCA location for cultural service supply and demand. The country is home to a diversity of PLCA models (see Chapter 3) that are managed under relatively well-developed policies and rules (Cumming & Daniels 2014) and boasts a diverse and growing ecotourism industry. For the Western Cape Province, I assessed which categories of factors and which individual factors best explained visitation rates to my sample of PLCAs. Additionally, I investigated which ecological features present in PLCAs, facilities and activities provided by PLCAs and which cultural benefits were most important to visitors, as perceived by PLCA owners and managers. I hypothesized (H0) that socio-economic factors, such as infrastructure or marketing, play an important role in ecotourism because they may enhance the demand for, and utilisation of cultural services. Alternatively, (H1) ecological factors would show highest significance because they form the basis for the provision of cultural ecosystem services. Thirdly, (H2) a combination of socio-economic and ecological factors might be most relevant in determining ecotourism, since visitors make choices both due to what they want to experience and how these experiences are facilitated.

5.1.2 Study Area

Ecotourism across southern Africa generates roughly the same revenue as farming, forestry and fisheries combined and has steadily increased in South Africa in the past decades (Loon & Polakow 2001; Scholes & Biggs 2004; Akinboade & Braimoh 2010) (Loon & Polakow 2001; Scholes & Biggs 2004). Ecotourism provides incentives for nature conservation and has the potential to contribute to poverty alleviation by increasing demand for local products and through job creation (Binns & Nel 2002; Spenceley et al. 2002; Chape et al. 2005; Lindsey et al. 2007). It thus plays a vital role in conservation and development in South Africa, a country which is still impacted by its apartheid history and which needs to develop socially just, economically viable and ecologically appropriate land-uses (Ramutsindela 2004; Langholz & Kerley 2006). For South Africa, the attraction of ecotourism lies in the country's biodiversity; with features such as accessible wildlife, varied and impressive scenery and unspoiled wilderness areas. The Western Cape Province is an area of high conservation value. As the sole African winter rainfall region south of the Equator, it incorporates the Cape Floral Kingdom, which is one of the world's 25 biodiversity hotspots (Myers et al. 2000). The province offers attractions for ecotourism such as the flowering of the West Coast Fynbos habitats, remote landscapes in the karoo biome, mountainous habitats on the Swartberg ridge, unspoiled wetlands and beaches along the Garden Route and, more generally, many endemic and endangered animal and plant species (e.g. Turner 2012). The PA network, which provides the opportunity for people to directly experience natural settings and benefit from cultural services, is important for ecotourism.

Alongside the statutory PAs, many private and co-managed conservation areas of different type and legal status exist in the province (see 1.9, Chapter 1). Based on their corporate models, two main PLCA types can be characterized in the Western Cape Province (Chapter 3). *Game reserves* are on average larger in size, employ more staff members, keep large mammals on the property, are relatively self-sufficient, offer guided drives, and make a higher marketing effort. *Habitat reserves* by contrast are usually associated with less active management and marketing effort, more indigenous flora and fauna, and are more often gazetted (Chapter 3). The different PLCA types in the province provide a suitable consistent legislative and socio-economic context for an assessment of visitation rates. Such an assessment is relevant to an understanding of how to maintain and enhance ecotourism in PLCAs. Ecotourism represents one source of continuity for building desired PLC resilience by supporting economic viability. Working within a single province further provides a consistent context, allowing for comparisons across the landscape and for a clear definition of the system to be assessed.

5.2 Data and Methods

5.2.1 Data and Data Collection

The data and PLCA property boundaries used for analyses were extracted from the dataset obtained during personal interviews, which are described in section 1.9, Chapter 1. Additional data extraction and spatial analyses were conducted with the tools ArcGIS 10.0, Google Maps, and GPS Visualizer (Schneider 2015) using the datasets listed in Table 1, and as explained below. Subsequent analyses are based on a sample of 64 PLCAs. Six study participants of the overall interview sample had to be excluded from this assessment because they did not generate income from visitors on a competitive basis (such as through accommodation, entrance fees, or regular offer of activities).

For data processing, categorisation and analyses, I largely followed the methodology of De Vos et al. (2016b). In total, 24 variables were considered as potential explanatory variables for variation in PLC ecotourism. They were grouped into response variables and predictor variables and several categories (Table 2).

Two variables were used as measures of ecotourism and thus as response variables. They were derived from the interview dataset and represented overall annual visitation rates (gate.arr) and number of international guests (int.guests) for each PLCA.

Table 1: Datasets used for analyses

Name of dataset	*Author*	*Details*
Protected Areas in South Africa	(De Vos 2014)	Inventory of protected areas in South Africa (national, provincial and private PAs)
Provincial Nature Reserves of the Western Cape	(Maciejewski 2014)	Inventory of provincial nature reserves in the Western Cape
NFEPA wetlands layer 2011. 1:50000	(BGIS 2015)	Inventory of wetlands in South Africa
River layer from South Africa's National Freshwater Ecosystem Priority Areas project. 1:500000	(BGIS 2015)	Inventory of freshwater systems in South Africa
Vegetation2006	(Mucina & Rutherford 2006)	Vegetation of South Africa
The South African National Land Cover 2000	(Van den Berg et al. 2008)	Land cover of South Africa

The predictor variables were grouped *a priori* into four categories, namely 'location', 'ecology', 'infrastructure' and 'discoverability/affordability'. The category *location* included eight variables. The size of each PLCA (park.size) was obtained from the interview dataset. Sizes of PLCAs have an influence on their corporate model as the extent of an area determines for example the carrying capacity of large mammals on the property or the space for long hikes or drives. From GoogleMaps, applying the tool for route planning, I extracted travel distances on roads in minutes to the nearest airport (air.time), the nearest town (town.time), the nearest national road (nroad.time) and the nearest coast (coast.time). Travel distances, measured in travel time, may have a strong influence on visitation rates because people may choose their destination with respect to how accessible a PA is or according to areas being in high demand (Hearne & Salinas 2002; Neuvonen et al. 2010). In this analysis I applied the assumption of a 'point-of-interest' approach. In many PAs there are long stretches of uninteresting roads which, however, lead to a final destination being of importance to visitors which is why visitors are willing to drive longer distances. I calculated the number of provincial PAs (pr.no), national parks (np.no) and PLCAs (ppa.no) within a 100km buffer around each PLCA. The surrounding context may influence the attractiveness of a PA if, for example, guests are travelling along a planned route and wish to visit several PAs on their trip which differ in terms of species or activities on offer.

The category *ecology* comprised seven variables. Ecological values of a PA are key driver for ecotourism (Dramstad et al. 2006; Neuvonen et al. 2010). In particular, charismatic wildlife is attractive to many international but also local guests (Maciejewski & Kerley 2014a). The number of mammal species (mammal.no) and Big5-species (Big5.no) in each PLCA was derived from interview data. Water has a strong influence on ecotourism as it attracts animals which can then be viewed more easily, provides recreational experiences and is aesthetically pleasing to people (Nassauer et al. 2007). Similarly, vegetation and the diversity thereof influences large mammal carrying capacity, diversity and visibility (Dramstad et al. 2006), and is influenced by the elevation of a destination. Thus, I extracted the elevation (elevation), number of waterbodies (waterbodies), the presence of rivers (rivers) and the number of different land cover classes (land.classes) for each PLCA as well as whether or not a PA is situated in- or outside the Fynbos biome (fynbos).

The category *infrastructure* consisted of two variables. An index for both the number of facilities (fac.no) and the number of activities (act.no) in each PLCA was extracted from interview data. Each index represented the relation between the total potential number of facilities or activities, respectively (obtained from the overall sample) compared to the actual number per PLCA. Infrastructure, measured both in terms of facilities and activities provided by a PLCA, represents aesthetic, recreational and experience-of-wilderness cultural ecosystem services. These three types of cultural ecosystem services are most commonly associated with ecotourism (Ode et al. 2008), and are thus important for this analysis in order to assess the variation in visitation rates to PLCAs.

Table 2: Response and predictor variables used to test variation in PLC ecotourism

Ecotourism (response)	*Location (predictor)*	*Ecology (predictor)*	*Infrastructure (predictor)*	*Discoverability / Affordability (predictor)*
Gate.arr (Number of overall visitors)	**Air.time** (Travel time to nearest airport)	**Waterbodies** (Presence of waterbodies in PLCAs, y/n)	**Fac.no** (Index: provided facilities per PLCA, min 0, max 6; e.g., restaurant, accommodation, conference venue)	**Marketing** (Index: number of applied marketing mechanisms per PLCA, min 0, max 5; website, brochures, agents, newspaper adverts, other (such as word of mouth))
Int.guests (Number of international visitors)	**NRoad.time** (Travel time to nearest National Highway)	**Elevation** (Mean elevation of PLCAs)	**Act.no** (Index: offered activities per PLCA, min 1, max 10; e.g., guided drive, hiking, mountain biking, biltong hunting, birding)	**Interact.ent** (Number of interactions to external entities per PLCA; such as companies, research institutions,)
	Coast.time (Travel time to nearest coast)	**Land.classes** (Number of land cover classes in PLCAs)		**Interact.PAs** (Number of interactions to other protected areas per PLCA)
	Town.time (Travel time to nearest town)	**Mammal.no** (Number of mammal species in PLCAs)		**Av.charge** (Average accommodation prices per night)
	Park.size (PLCA property size)	**Big5.no** (Presence of Big 5 -species, y/n)		
	NP.no (Number of National Parks in proximity)	**River** (Presence of river in PLCAs, y/n)		
	PR.no (Number of Provincial Reserves in proximity)	**Fynbos** (PLCAs located in Fynbos biome, y/n)		
	PPA.no (Number of PLCAs in proximity)			

The category for *discoverability/affordability* included four variables. From interview data I derived the number of different entities (external collaborators such as research institutions, authorities or companies) that each PLCA interacts with (interact.ent) as well as the number of other PAs (national, provincial and private PAs) that each PLCA interacts with (interact.pa). These connections to external collaborators can support the publicity of a PLCA e.g. due to enhanced marketing which is important to create awareness about a PLCA's existence (Lai & Shafer 2005). An index for individual marketing effort of each PLCA was used (marketing), which was also obtained from the interviews and represents how many different marketing avenues are being used (e.g. website, advertising in magazines etc.). Average accommodation charges per person per night in South African Rand (av.charge) were either provided during interviews or researched from PLCA websites. Prices refer to average amounts for the year 2014. Pricing may influence a visitor's choice of destination depending on their budget and how much money they are willing to spend for an ecotourism experience (Seddighi & Theocharous 2002).

Tourism is dynamic and guest numbers were averages. Some PLCAs kept accurate booking systems whereas others kept rough records and thus provided estimates of visitation rates, in as much detail as possible. The stated information spanned a two-year timeframe during which interviews were undertaken.

5.2.2 Data Analysis

I first used redundancy analysis and variance partitioning, which quantify broad patterns and interactions of variable categories in relation to the response variables (e.g. Borcard et al. 1992; Legendre & Legendre 2012), to identify groups of variables that best explained spatial variation in ecotourism. This was followed by analysis using generalized linear mixed models (GLMMs) to further identify and validate the significance of specific predictor variable groups and of individual predictor variables.

Data preparation and reduction

Prior to running RDA and GLMMs, all response as well as predictor variables were standardized to zero mean and unit deviation to remove the effects of scale. Standardization is of particular importance to the predictor variables in order to avoid single variables dominating the model and resulting in biases.

I then reduced the number of variables used in the GLMMs to avoid overfitting. Prior to running full models, pairwise correlation tests were conducted to reduce the overall number of variables and avoid collinearity. Where a strong correlation occurred, generally the variable with the stronger relation to the response variables was chosen. For example, the variable ‘park.size’ dominated ‘elevation’. Further, some variables with weak relations to the response variables were dropped from the analyses, such as ‘coast.time’ or ‘interact.ent’. However, in a few instances I did not remove competing variables from the analyses in order to have the full set of factor types represented, according to my a priori hypotheses. For example, ‘park.size’ and ‘waterbodies’ indicated some correlation but were both thought to be relevant in the models.

The remaining sub-set included 12 variables (Table 3) which represented the fixed effects used in the models: reserve size (park.size), travel time to nearest airport (air.time), number of national parks in 100km buffer (np.no) and number of private reserves in 100km buffer (ppa.no) representing factors of location; number of large mammal species (mammal.no), number of Big 5-species (Big5.no), whether or not reserves were situated in- or outside the Fynbos biome (fynbos) and number of water bodies (waterbodies) representing factors of ecology; number of facilities provided (fac.no) and number of activities provided (act.no) representing factors of infrastructure; marketing effort (marketing) and average accommodation charges (av.charge) representing factors of discoverability/affordability. The use of site as a random effect allowed data from all sites to be combined in a single analysis.

Table 3: Variable categories and corresponding variables used in generalized linear mixed models to test variation in Private Land Conservation ecotourism

Category	Corresponding Variables
Location	PLCA size (park.size) Travel time to nearest airport (air.time) Number of national parks in 100 km buffer (np.no) Number of private reserves in 100 km buffer (pr.no)
Ecology	Number of large mammals (mammal.no) Number of Big 5-species (Big5.no) PLCA situated in Fynbos biome or not (fynbos) Number of waterbodies (waterbodies)
Infrastructure	Number of facilities (fac.no) Number of activities (act.no)
Discoverability	Marketing effort (marketing)
Affordability	Average accommodation charges (av.charge)

Redundancy Analysis and Variance Partitioning

RDA was conducted in R (R Core Development Team 2014), version 3.0.0 using the **vegan** package (Oksanen et al. 2013). RDA is related to regression in that an attempt is made to explain the variance in a dependent variable using a set of explanatory variables. What differentiates RDA is that there are multiple explanatory (independent) variables as well as multiple dependent variables, i.e. multiple X variables and multiple Y variables. The final aim of an RDA is usually to find the set of explanatory variables (represented as tables of predictor variables) that explains the greatest amount of variance in the set of dependent variables (represented by a table of response variables). Finding explanatory variables is achieved by a two-step process. First, a regression model is built of the multiple explanatory variables on the multiple dependent variables. In **vegan** this is executed by the function rda(). Second, the variance in the dependent variables is partitioned in order to find the set of explanatory variables which explains the greatest amount of variance observed in the dependent variables. This is carried out by the function varpart() which provides results in the form of pure explanatory fractions of variation for the response table as well as shared explanatory fractions, indicating interaction among variables from different groups.

The response table comprised the variables representing measures for ecotourism, as described above, and the predictor tables comprised the four categories of variables: ecology, location, infrastructure and discoverability/affordability. Results are stated as adjusted R^2 values which account for the inflation of R^2 associated with the sample size and number of predictor variables. The significance of the overall model fit and the significances of variable effects were tested using an ANOVA.

Generalized linear mixed models

My primary goal was to model visitation rates in private reserves as function of the variable categories I created earlier on (namely location, ecology, discoverability/affordability, and infrastructure). To identify the significance of variable groups and importance of individual driving factors, I ran two sets of models: one that assessed the variation in overall visitation rates (gate.arr) and one that assessed the variation in number of international visitors (int.guests). I did not investigate type of accommodation as a separate response variable in these models because of concerns about overfitting.

Firstly, for each set, I ran a 'full model' which included all 12 predictor variables. Then I tested the effects of variable groups by sequentially removing each of the categories (and all corresponding variables) from the full model and re-running it. In this step of the analysis, I separated the variables of the category 'discoverability/affordability' into two categories as I was particularly interested whether discoverability and affordability had differing effects on visitation rates. This left me with 5 categories. Finally, I also ran an intercept only model, for reference. In total, I thus ran 14 models where each of the two sets (for overall gate arrivals and international guests) comprised a sub-set of seven models (full model, intercept model and 5 category models) (Table 4 and 6).

The GLMMs were fitted in R, using the **lme4** package (Bates et al. 2015) and applying the **glmer** function, with Maximum Likelihood Estimation for Poisson counts. All GLMMs were tested for collinearity using the Variance Inflation Factor (VIF) (Zuur et al. 2010), which measures the inflation of variance in the estimated regression coefficients which is caused by multicollinearity. The presence of multicollinearity in the model affects the accuracy of the regression coefficients, distorting the impact of the independent variables on the dependent variables. The square root of the VIF shows how inflated the standard errors are in comparison to a model without collinearity problems. Variables with high VIF-values, >10 or higher, were removed. Model selection of the best fit models in each instance was based on Akaike's information criterion [AIC; (Akaike 1974; Johnson & Omland 2004)]. AIC estimates the quality of each model, relative to each of the other model in a given collection of models for a certain data set.

Assessment of reserve types

Overall sample size of 64 PLCAs did not allow for a complete rigorous repetition of the described analyses in order to assess game reserves and habitat reserves separately. The sample could not be split into these two PLCA types in order to re-run the RDA/variance partitioning and the GLMMs with the same amount of variables. However, I assessed the residuals for the two best models (international and overall visitor numbers) for the two PLCA types using box plots in order to detect a potential significant difference. Furthermore, I used the four significant individual variables of the best fit models (international and overall visitor numbers) to run GLMMs in order to assess whether or not these variables explain visitation rates for both PLCA types.

Provision and Valuation of Cultural Services

PLCA owners and managers were asked to rate the importance of several factors which influence the supply and demand of cultural ecosystem services, and thus visitation to their reserves. These ratings were based on the personal experiences and perceptions of PLCA owners and managers and not on a survey directly addressed at visitors. Ecological features of PLCAs, provided activities and facilities as well as visitation purposes were rated according to importance. These assessments provided an indication of visitor choices which may strongly determine the ecotourism success of PLCAs. They highlighted potential options for improving ecotourism as source of PLCA continuity. Ratings were analysed using descriptive statistics.

5.3 Results

5.3.1 Redundancy Analysis and Variance Partitioning

The results of the RDA and variance partitioning showed that all four groups of predictor variables explained fractions of variation in PLC ecotourism (Figure 1). The combined model explained 38% of the variation in the response table and left 62% of the variation unexplained to unidentified factors. The proportion of explained variation was significant (p = 0.001).

Exclusive effects from individual fractions were only significant for one group of predictor variables, infrastructure, which explained 6% of overall variation in visitor numbers (p = 0.02, F = 3.1). All other groups of predictor variables did not show significant exclusive effects. Instead, overall effects from global fractions (i.e., combined effects from several groups of variables) for all four groups of predictor variables were significant. These overall effects of global fractions are, in Figure 2, represented by all values within a circle corresponding to a certain variable. Elements of ecology and location explained the largest proportion of overall variation in PLCA ecotourism with 26% (p = 0.002, F = 4.2) and 22% (p = 0.006, F = 3.2), respectively. Discoverability/affordability and infrastructure variables accounted for 12% (p = 0.029, F = 3.1) and 12% (p = 0.002, F = 5.3), respectively.

5.3.2 Generalized Linear Mixed Models

The GLMMs identified similar general patterns to those identified by the RDA by showing that predictor variables of different groups explained some but not all of the variation in PLCA ecotourism. The best model (Table 4) for explaining overall visitation rates (gate.arr) represented the candidate model in which location variables were removed. This means that location variables (travel times, size of reserves or other protected areas occurring in proximity) were not strongly contributing to explaining overall visitation rates. Rather, variables of the categories infrastructure, discoverability, affordability and ecology played a stronger role in attracting visitors to PLCAs.

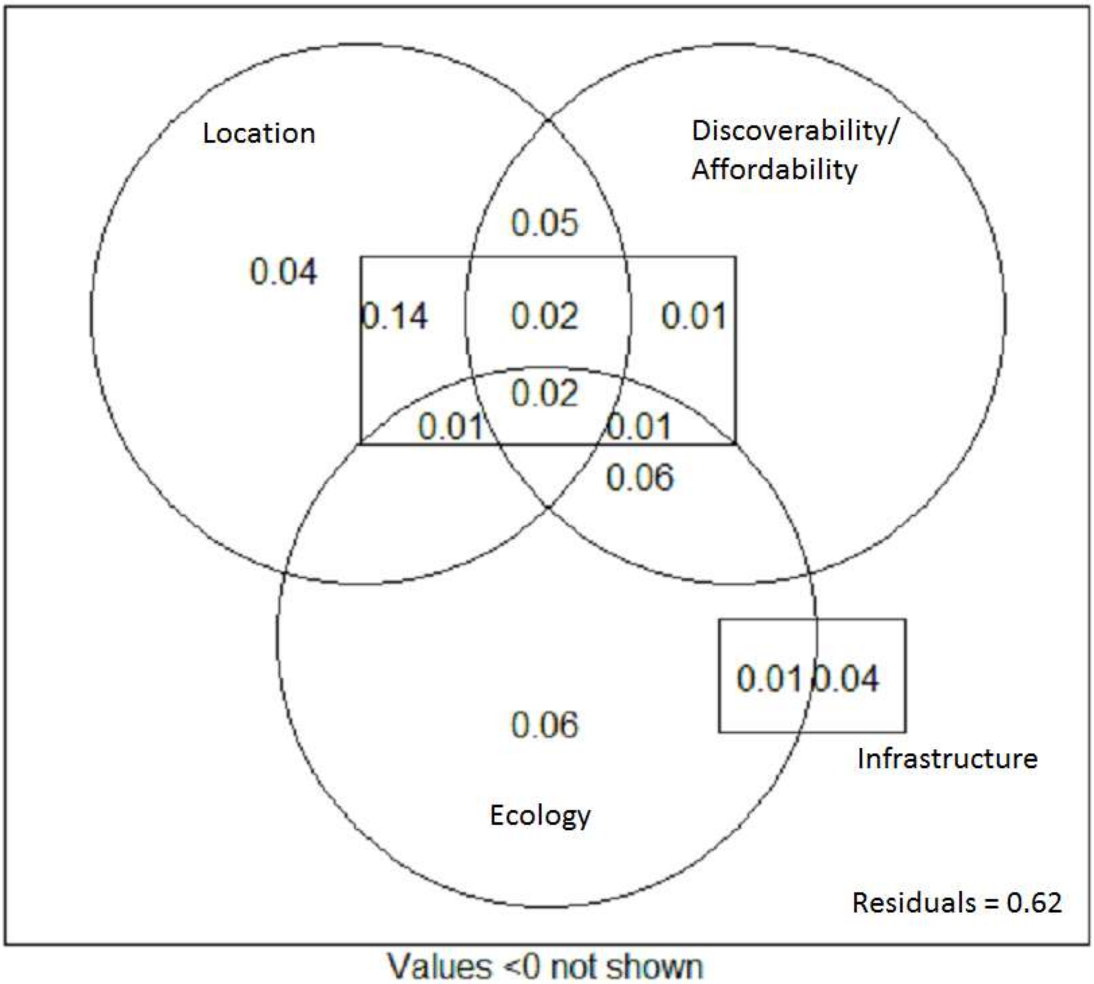


Figure 1: Venn diagram depicting the proportion of variation (Adj. R²) in PLC ecotourism in the Western Cape Province; as explained by elements of location, ecology, infrastructure and discoverability/affordability

When examining model coefficients for individual variables in the best model for overall visitation rates (Table 5), the number of mammal species (mammal.no), number of Big 5-species (Big5.no) and average accommodation charges (av.charge) were significant ($p < 0.05$) in explaining overall visitation rates. Thus, factors of the groups ‘ecology’ and ‘affordability’ in combination best explained high visitation rates of overall guests to PLCAs when assessing individual main effects.

Table 4: Candidate models and comparison statistics for the 7 generalized linear mixed models (labelled with IDs) predicting the variation in visitation rates of overall visitors to private reserves in the Western Cape Province. [AIC: a lower AIC indicates a better fit; ΔAIC indicates difference in AIC scores between each model and the best fit model; k indicates number of model parameters]

Candidate model	*AIC*	*ΔAIC*	*k*
Location removed (4): Marketing + Fac.No + Act.No+ Mammal.No + BIG5.No + Waterbodies + Fynbos + Av.Charge	51.6468	0	10
Discoverability removed (2): Fac.No + Act.No+ Air.Time + Park.Size + NP.No + PPA.No + Mammal.No + BIG5.No + Waterbodies + Fynbos + Av.Charge	57.0012	5.4	13
Infrastructure removed (3): Marketing + Air.Time + Park.Size + NP.No + PPA.No + Mammal.No + BIG5.No + Waterbodies + Fynbos + Av.Charge	57.4329	5.8	12
Affordability removed (6): Marketing + Fac.No + Act.No+ Air.Time + Park.Size + NP.No + PPA.No + Mammal.No + BIG5.No + Waterbodies + Fynbos + Av.Charge	59.7369	8.1	14
Ecology removed (5): Marketing + Fac.No + Act.No+ Air.Time + Park.Size + NP.No + PPA.No + Mammal.No + BIG5.No + Waterbodies + Fynbos + Av.Charge	59.7369	8.1	14
Full Model (1): Marketing + Fac.No + Act.No+ Air.Time + Park.Size + NP.No + PPA.No + Mammal.No + BIG5.No + Waterbodies + Fynbos + Av.Charge	59.7369	8.1	14
Intercept Only (7)	64.5160	12.9	2

Table 5: Model coefficients for best-fit model (location variables removed) predicting overall visitor numbers to private reserves. Results include coefficient estimate (β), standard error SE(β), associated Wald's z-score (β/SE(β)) and significance level p for all predictors

Category	*Fixed effect*	*β*	*SE(β)*	*z*	*p*
Discoverability	Marketing	0.3898	0.7266	0.536	0.59
Infrastructure	Fac.No	1.2805	0.6854	1.868	**0.06**
	Act.No	0.3889	0.6206	0.627	0.53
Ecology	Fynbos	0.7228	0.7917	0.913	0.36
	Mammal.No	-1.0301	0.4813	-2.140	**0.032**
	BIG5.No	1.2287	0.3663	3.354	**0.0008**
	Waterbodies	0.3288	0.2923	1.125	0.26
Affordability	Av.Charge	-1.4868	0.6900	-2.155	**0.031**

As with the 'overall visitor number' models, location variables contributed least to the best model (Table 6) for explaining international visitation rates (int.guests). Two further candidate models ('infrastructure removed' and 'discoverability removed') showed AIC-values within ΔAIC=2.

When considering model coefficients for individual variables in the best model (Table 7), similar results to those found with the "overall visitation rates" model emerged. Here again, the number of mammal species (mammal.no), number of Big 5-species (Big5.no) and average accommodation charges (av.charge) significantly ($p < 0.05$) explained variation in international visitation rates. Additionally, the number of facilities provided (fac.no) significantly ($p < 0.05$) explained numbers of international visitors. Thus, factors of the groups 'ecology', 'affordability' and 'infrastructure' in combination best explained high visitation rates of international guests to PLCAs when assessing individual main effects.

Table 6: Candidate models and comparison statistics for the 7 generalized linear mixed models (labelled with IDs) predicting the variation in visitation rates of international visitors to private reserves in the Western Cape Province. [AIC: a lower AIC indicates a better fit; ΔAIC indicates difference in AIC scores between each model and the best fit model; k indicates number of model parameters]

Candidate model	*AIC*	*ΔAIC*	*k*
Location removed (4): Marketing + Fac.No + Act.No+ Mammal.No + BIG5.No + Waterbodies + Fynbos + Av.Charge	48.1	0	10
Infrastructure removed (3): Marketing + Air.Time + Park.Size + NP.No + PPA.No + Mammal.No + BIG5.No + Waterbodies + Fynbos + Av.Charge	48.7	0.5	12
Discoverability removed (2): Fac.No + Act.No+ Air.Time + Park.Size + NP.No + PPA.No + Mammal.No + BIG5.No + Waterbodies + Fynbos + Av.Charge	50.0	1.9	13
Affordability removed (6): Marketing + Fac.No + Act.No+ Air.Time + Park.Size + NP.No + PPA.No + Mammal.No + BIG5.No + Waterbodies + Fynbos + Av.Charge	52.3	4.2	14
Ecology removed (5): Marketing + Fac.No + Act.No+ Air.Time + Park.Size + NP.No + PPA.No + Mammal.No + BIG5.No + Waterbodies + Fynbos + Av.Charge	52.3	4.2	14
Full Model (1): Marketing + Fac.No + Act.No+ Air.Time + Park.Size + NP.No + PPA.No + Mammal.No + BIG5.No + Waterbodies + Fynbos + Av.Charge	52.3	4.2	14
Intercept Only (7)	64.4	16.2	2

Table 7: Model coefficients for the best-fit model (location variables removed) predicting <u>international visitor numbers</u> to private reserves. Results include coefficient estimate (β), standard error SE(β), associated Wald's z-score (β/SE(β)) and significance level p for all predictors

Category	*Fixed effect*	*β*	*SE(β)*	*z*	*p*
Discoverability	Marketing	0.6059	0.8736	0.694	0.49
Infrastructure	Fac.No	1.6994	0.7885	2.155	**0.03**
	Act.No	0.1596	0.7010	0.228	0.82
Ecology	Fynbos	0.8130	0.9553	0.851	0.39
	Mammal.No	-1.3217	0.5482	-2.411	**0.016**
	BIG5.No	1.5158	0.4204	3.606	**0.00031**
	Waterbodies	0.3895	0.3211	1.213	0.23
Affordability	Av.Charge	-1.7529	0.7652	-2.291	**0.022**

5.3.3 Comparison of Game Reserves and Habitat Reserves

An assessment of the residuals of the two best models explaining visitation rates for international and overall visitor numbers did not show a significant difference for reserve types (Figure 2). This means, in the models testing the entire sample, no pattern could be detected according to which differing variables would specifically explain variation in visitation rates to either game or habitat reserves. Thus, I ran the best models with the split sample (exclusively for both game and habitat reserves).

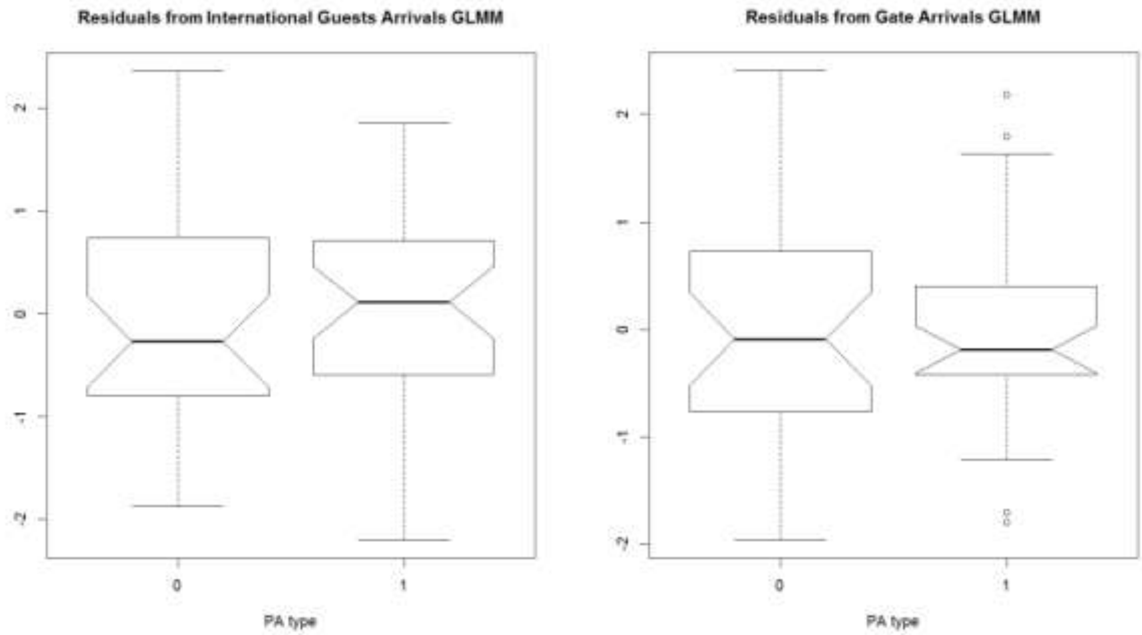


Figure 2: Box plots comparing the residuals of the best fit models for international (left) and overall visitor numbers (right). PA type 0 = habitat reserves; PA type 1 = game reserves.

International visitation

In the best model as analysed for the split sample, two variables were significant for explaining international visitation rates to game reserves. These were number of facilities ($p < 0.01$) and presence of Big 5-species ($p < 0.001$). For explaining international visitation to habitat reserves, no variable of the best model was significant.

Overall visitation

In the best model, again two variables were significant for explaining overall visitation to game reserves. These were again the number of facilities ($p < 0.001$) and the presence of Big 5-species ($p < 0.001$). Interestingly, the number of activities was significant for explaining overall visitation to habitat reserves ($p < 0.05$).

5.3.4. Provision and Valuation of Cultural Services

PLCA owners and managers provided insight about how visitors perceive the ecological features accessible on their properties. According to the experience of PLCA owners and managers, vegetation is most important to their visitors. Second rated large mammals which were closely followed by birds (Figure 3). Interestingly, Big 5-species rated rather low for visitors as perceived by owners and managers, although many PLCAs market these charismatic species. Many visitors also seem to show strong interest in endemic and endangered species, which rated fourth and fifth.

As for facilities and activities provided by PLCAs, accommodation in form of chalets, guided drives on sites and birding opportunities are most important for visitors according to the experience of PLCA owners and managers (Figure 4).

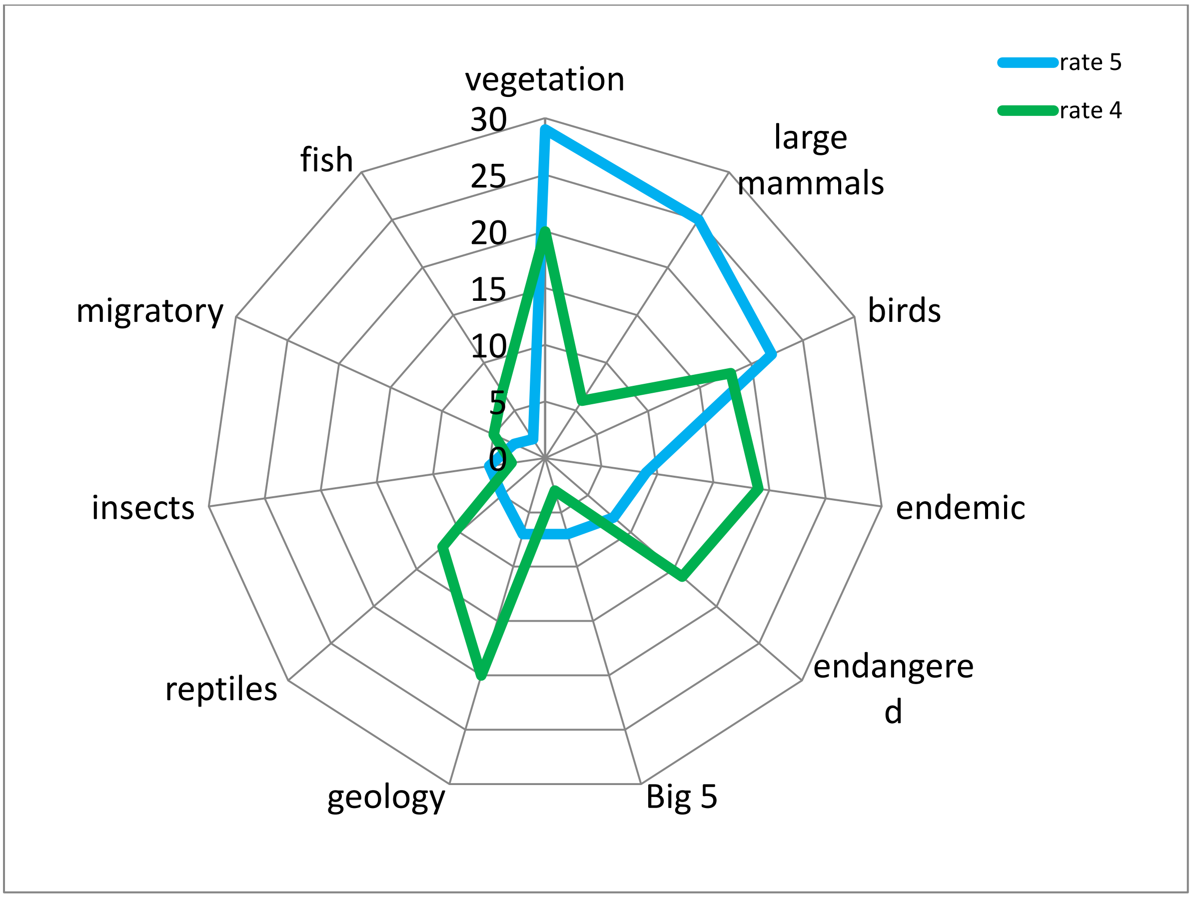


Figure 3: Importance of ecological features to PLCA visitors, as rated by owners and managers according to their experience, on a scale from 1 (not relevant) to 5 (very important). (Original interview question: 'Based on your perception, how do the ecological features of your park generally rank to your visitors? Please rank on a scale from 1 (not relevant) to 5 (very important)'; General Questionnaire)

In relation to cultural benefits accessible to visitors, 'connecting with nature' was the most important reason to make use of PLCAs in the Western Cape Province as perceived by owners and managers (Figure 5). Further important cultural benefits were 'inspiration', 'recreation', 'learning', 'sense of place' and aesthetics'.

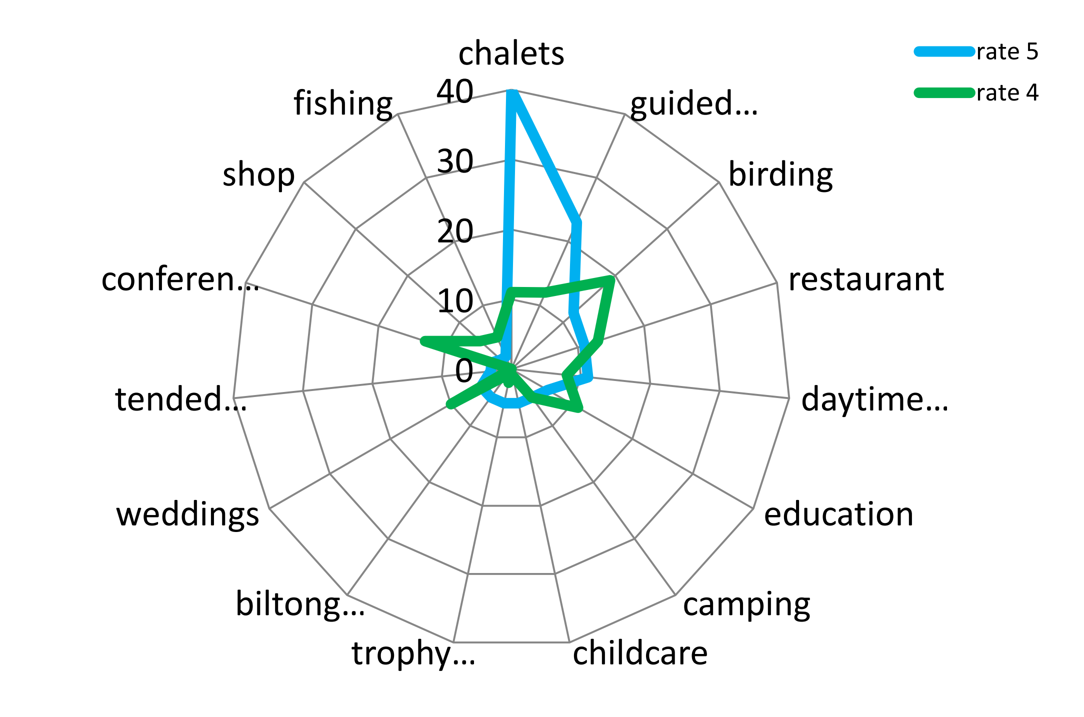


Figure 4: Importance of facilities and activities to PLCA visitors in the Western Cape Province, as rated by owners and managers according to their experience, on a scale from 1 (not relevant) to 5 (very important). (Original interview question: 'How do these social facilities rank in importance to your visitors, according to your experience/opinion? Please rank on a scale from 1 (not relevant) to 5 (very important)'; General Questionnaire)

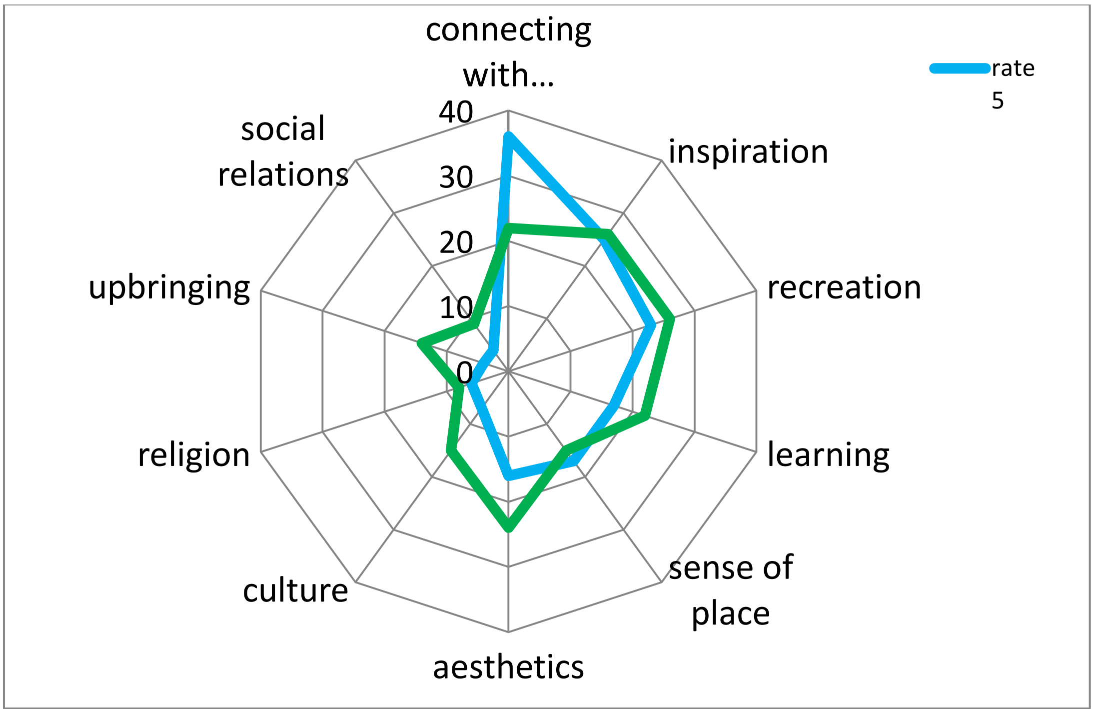


Figure 5: Importance of cultural benefits to PLCA visitors as reasons for visiting PLCAs in the Western Cape Province, as rated by owners and managers according to their experience, on a scale from 1 (not relevant) to 5 (very important). (Original interview question: 'Based on your perception, for which purpose do your visitors come to your park? Please rank on a scale from 1 (not relevant) to 5 (very important)'; General Questionnaire)

5.4 Discussion

A substantial proportion (38%) of the variation in visitation to PLCAs in the Western Cape Province of South Africa could be explained by a relatively small number of variables. These variables were convenient to obtain from interviews, basic data extraction via online tools and spatial information and thus make the applied analysis feasible for comparable research approaches.

The overall findings indicated that visitation to PLCAs was influenced by a combination of factors which determined the context of a PLCA and a visitor's behaviour. Different factors of all major categories had an effect on tourist numbers: the ecological features of a PLCA, its location and surrounding context, the provided infrastructure and the discoverability and affordability. There was, however, a strong hierarchy in importance among these categories where ecological variables best explained visitation rates (26%), closely followed by factors of location (22%). The categories of infrastructure and discoverability/affordability were less influential in the main model (12% each). These combined effects of variable groups were all significant, whereas exclusive effects for variable groups were only significant for infrastructure. In comparison to the variance partitioning model, which assessed the effects of variable categories and their interactions, the generalized linear mixed models identified individual variables which explained visitation rates. Some of the patterns found in the overall model could be verified. For both international and overall guest numbers two ecological variables (the number of mammal species and the presence of Big 5-species) and one variable each for infrastructure (the number of facilities positively) and affordability (average accommodation charges) predicted variation in visitation rates

Generally, it became apparent from the presented findings that a combination of factors drives visitation rates to PLCAs in the Western Cape Province. Both ecological and socio-economic factors influence PLC ecotourism, in combination with spatial factors, which verified the second alternative hypothesis and suggests that visitors make complex decisions about their chosen destinations, as was found in other PA types and countries (De Vos et al., 2016b; Chan & Baum 2007). This is perhaps not too surprising, as ecological features are the basis for PLC existence. They determine the corporate model which can be adopted including the type of ecotourism which can be offered to guests (Clements et al. 2016), e.g. by determining the carrying capacity for wildlife and the scenic landscapes for activities such as game viewing or mountain biking. Socio-economic conditions and contexts then influence the demand and utilisation of cultural services provided by PLCAs. Factors of infrastructure and affordability determine the choices and behaviours of guests.

For PLCAs and in general, ecotourism and biodiversity conservation are linked phenomena. On the one hand, ecotourism in PLCAs contributes to biodiversity and ecosystem conservation (Langholz & Lassoie 2001; Cousins et al. 2008). It can, for example, help to directly finance and ensure conservation of threatened species and habitats such as for the wild dog in South Africa or for oak forests in the USA (Lindsey et al. 2005; Knoot et al. 2010). On the other hand, ecotourism is increasingly dependent on PLCAs because statutory PAs in developing countries may be underdeveloped and insufficiently funded (Barany et al. 2001; Bruner et al. 2004). Further, private ecotourism initiatives can have substantial economic impact on local people (Spenceley & Goodwin 2007). PLC in recent years is increasingly perceived as strategy for achieving biodiversity conservation targets in an increasingly stringent economic climate (Stolton et al. 2014). Whereas many practitioners feel that PAs have greater intrinsic value as conservation instruments than as mechanisms for generating ecotourism income (Buckley 2009), the reality is that the former can no longer exist in practice without some measure of the latter and visitation to parks creates a political argument for managing conservation areas. My results highlight several interesting patterns in PLC ecotourism that have important international implications for the economic viability and thus continuity of PLCAs. The insights can be used to develop new approaches to pricing in PLC ecotourism (Alpízar 2006).

Among the four significant individual predictors of overall and international visitor numbers, as identified in the GLMMs for the entire sample, both the number of mammal species and average accommodation charges showed a negative relation to the response variables. Number of facilities and Big 5-species were positively related. This means that PLCAs with many facilities and Big 5-species receive more visitors than PLCAs which do not provide these features. These two features resembled the main characteristics of the adopted corporate model of 'game reserves' (see Chapter 3). These results suggest that game reserves have the highest visitation rates among PLCAs in the Western Cape Province. Interestingly, visitors also seemed to be attracted to reserves with lower average accommodation charges (as explained by the negative relation in the models) because pricing schemes in most Big 5-reserves are higher in comparison to habitat reserves, often referred to as high-value low-volume tourism (Magole & Magole 2011). Further, when analysed separately, visitation to game reserves was significantly explained by the two variables 'number of facilities' an 'presence of Big 5-species'. These findings support the interpretation that the corporate model of game reserves attracts many tourists. Contrarily, visitation to habitat reserves was significantly explained by the variable 'number of activities'. This finding supports the argument that a market may exists for ecotourism which does not focus on safari-type experiences with charismatic species.

Overall, many other potential drivers of ecotourism were not significant in explaining visitation rates. It thus appeared that the adopted PLCA corporate model was more influential in attracting many tourists than other variables such as marketing or specific ecological features like waterbodies. Game reserves, however, are significantly more often situated outside the Fynbos biome which indirectly emphasizes the influence of location (see Chapter 3). This has important implications for PLC as a strategy for biodiversity conservation, since habitat reserves may be protecting more biodiverse areas and have more eco-centric management practices than game reserves often stocking charismatic and extralimital species (Maciejewski and Kerley 2014b). Game reserves may be economically incentivised to do so as charismatic species attract high numbers of visitors (Maciejewski and Kerley 2014a) and these visitors allow for large financial profits to be generated, however, also require PLCAs to adopt a corporate model of high maintenance. Game reserves, on average, may have more earning potential than habitat reserves, but also face higher costs (keeping large mammal species causes e.g. the need for the employment of more staff members and the provision of larger facilities). Charismatic species are thus both the cause and solution to high costs and income from ecotourism (Di Minin et al. 2013). This leads to a second, related implication: Although visitation rates (and potential economic revenue) in game reserves may be higher than in habitat reserves, this does not necessarily mean that the former are more economically viable or do not present important cultural benefits to society and that these are not highly valued by users. This argument is strongly supported by my findings showing that visitors valued vegetation and birds as much more important features than Big-5 species according to PLCA owners and managers. Furthermore, accommodation in form of chalets, guided drives and birding opportunities were most important facilities and activities provided to visitors. Thus it would be important to address the situation of habitat reserves with other measures in order to understand their cultural service provision and its utilisation by guests. Overall, visitors seem to utilise PLCAs to 'connect with nature' as most important purpose, followed by accessed cultural benefits of 'inspiration', 'recreation' and 'learning'. For national parks, Ament et al. (2016) found corresponding patterns in cultural services bundles where aesthetic services, recreational services, spiritual services and safari-experiences are distinct groups of benefits with some strong trade-offs among each other.

At broader scales, my findings suggest that there may be scope for PLCAs with differing objectives and approaches. Tourists are attracted by certain pull factors (Chan and Baum, 2007) but there are different demographics and types of visitors and there may be a trade-off between them. More experienced and revisiting tourists and also local guests in South Africa tend to distance themselves from charismatic species and focus more on local birds and vegetation (Lindsey et al. 2007). This clientele is probably very important for habitat reserves which tend to provide non-safari type of activities and be less business-oriented. In Brazil, De Vasconcellos Pegas & Castley (2014) found that most PLCAs which engage in ecotourism are of small size and focus on outdoor and educational activities. There is large potential to increase ecotourism in these small reserves which also enhance conservation outcomes. Thus, we may need different kinds of PAs to provide a diversity of important cultural benefits to wider society. Implicit in this observation is that different kinds of PAs may also cater to different socio-economic classes and demographics, and consequently might require different corporate management models focusing on different bundles of cultural ecosystem services provided. This poses a challenge and might not be a straight forward intuitive decision in many cases, however, also represents an opportunity for improving ecotourism success and thus economic viability.

De Vos et al. (2016b) found accommodation costs to be a very important explanatory variable in variation of ecotourism rates in South African National Parks. In their study, visitors were also more strongly influenced by ecological variables, and far less by elements of location. In National Parks, ecotourism seems to depend more on the ecological features in a PA and its economic context. Interestingly, a much higher proportion (63%) of variation in tourist numbers could be explained by contextual factors than the 38% I observed in my assessment. National parks represent a somewhat consistent system with more homogenous management and dynamics in comparison to PLCAs. Facilities and activities provided and the marketing strategies show similar patterns and thus may explain why specific features and the financial settings have a higher influence. For PLCAs these conditions and dynamics are not uniform because every PLCA acts in an independent and individual manner with unique objectives. This diversity of PLCA models probably explains the large proportion of unexplained variation in my study and suggests that different factors need to be considered in designing optimal PLC management plans compared to statutory models and strategies. Encouragingly, PLC may be able to provide national PA networks with a greater diversity of PAs, increasing redundancy and resilience of the larger PA network which, however, does not necessarily refer to present complementarities.

In conclusion, it appears that the economic success of PLCAs depends strongly on management objectives as well as on what people want to utilize and experience or how they perceive and value an area and their time spent at a destination. Thus the economic success of PLCAs is driven by the spatial heterogeneity of factors which influence both the potential corporate models and visitor choices. Since visitation rates are strongly influenced by ecological factors and their socio-economic context, individual PLCAs can improve their ecotourism success by focusing on the development, enhancement and increased utilisation of these drivers according to their specific opportunities and purposes.

Chapter 6: The Conservation Contribution of the Private Conservation Estate: Opportunities and Challenges

6.1 Introduction

From the global to the local scale, conservation planning is an extremely important tool in biodiversity conservation (Reyers et al. 2010; Smith et al. 2010; Whitehead et al. 2014). It helps to ensure that the conservation estate and additional conservation action are sufficient in extent as well as functionality to achieve biodiversity conservation according to targets and beyond. For example, the international Aichi target 11 of the Convention on Biological Diversity aims to have at least 17% of the global terrestrial and inland water areas under protection by 2020 (CBD Secretariat 2015b). Statutory protected areas (PAs) in South Africa currently represent 10.67% of total national land and the aim is to protect 13.7% of terrestrial land by 2018/19 (Department of Environmental Affairs and Tourism 2014).

Statutory PAs play a vital role in conservation (Adams 2004; Chape et al. 2005), however, they are often insufficient for achieving current targets (e.g. Barnard et al. 1998; Barany et al. 2001; Von Hase et al. 2010; Lindsey et al. 2014), being located in marginal areas of high elevations and steep slopes (Joppa & Pfaff 2009). Many areas of high conservation value, however, occur in high production landscapes of which substantial sections are privately owned, such as in the Western Cape Province (Gallo et al. 2009). Private Land Conservation (PLC) and other forms of private conservation action are thus of increasing importance for maintaining and expanding the global conservation estate (Barnard et al. 1998; Fitzsimons & Wescott 2001; Child et al. 2013), for example by preserving habitats in production landscapes from being transformed into agricultural land-uses. In the Western Cape Province, agricultural expansion was a major reason for the loss of Critical Biodiversity Areas in recent years (Pence 2014).

Ecological factors commonly are the basis to determining the choice of areas which are to be protected, according to their irreplaceability (Cowling et al. 1999; Reyers 2004). Management philosophy shifted from a species to an ecosystem focus (Prato & Fagre 2005). Increasingly, socio-economic factors play a major role in conservation (such as landscape fragmentation, financial markets) and create urgency for the protection of remaining habitats and their ecosystem services provision to society. Incorporation of social values in conjunction with biological data is therefore critical in conservation planning (Whitehead et al. 2014). Further, Naidoo et al. (2006) argue that integrating economic costs into conservation planning can lead to larger biological gains despite limited budgets. For example, the willingness of landowners to sell property or to engage in conservation action can determine the availability of land for conservation according and thus determine conservation opportunity. Attitudes and choices of private landowners have a strong impact on conservation success and effectiveness (Kamal et al. 2015; Selinske et al. 2015). Willingness to collaborate in conservation in the Eastern Cape Province of South Africa, for example, was found to vary strongly among managers (Knight et al. 2010). In general, assessments of PAs with respect to management effectiveness combine three areas: PA design, management processes and ecological integrity (Ervin 2003).

Although Private Land Conservation Areas (PLCAs) have received increased attention, for example during the IUCN World Parks Congresses in 2003 and 2014 (see Chapter 1), they are still mostly not incorporated into strategies and assessments for conservation target achievement. Their exclusion is emphasized by the fact that UNEP's protected area inventory, the World Database of Protected Areas, does not include PLCAs (West et al. 2006; Stolton et al. 2014). Current gaps in knowledge about the extent and distribution of PLCAs are partly caused by the fact that many different definitions of PLCAs exist worldwide and that terminology is not applied uniformly making assessments difficult (Mitchell 2005; Carter et al. 2008). Many countries lack a national PLCA definition and do not keep inventories. Stolton et al. (2014) therefore call for a universal definition of PLCAs in order to facilitate consistent assessments and to better incorporate PLC into mainstream conservation: "A privately protected area is a protected area, as defined by IUCN, under private governance [...]". This definition, however, is based on a predominantly legal approach and thus distinguishes between statutory PLCAs (with formal status e.g. as contract reserves) and other conservation areas. Although this definition might be suitable on an international scale to consolidate an accurate record of private conservation with respect to achieving targets, it excludes all other existing privately owned conservation areas and types of private conservation action which are not tied to property rights or contracts from official records. Similarly, the IUCN categories for PAs have been criticized for representing a very Western approach and being exclusive towards non-Western cultures and traditional land uses (West et al. 2006).

Relating to the call for an official (legal) definition, there is debate about the potentially tenuous status of non-formal conservation areas which might not guarantee persistent sound management or coordinated decisions (Kreuter et al. 2010). It is feared, that areas which are not formally designated for conservation in the long-term (at least 25 years) or even in perpetuity might change their land-use or purpose (Stolton et al. 2014). This would be of high concern from an ecological point of view (Langholz & Lassoie 2001). Despite this concern, non-formal conservation areas may contribute substantially to biodiversity conservation. The question arises whether or not such areas should receive formal protection status in order to expand statutory PA networks. They could represent an important target group for approaches to conservation initiatives and authorities. However, other mechanisms to support continuous private conservation action may as well be successful in achieving conservation targets, such as providing extension services, financial incentives or creating bridging organizations. A formal status 'in perpetuity' may not guarantee the safeguarding of biodiversity since even statutory PAs are under threat of downsizing or degazettement (Mascia & Pailler 2010). Conservation outcomes and ecosystem services provision can represent flexible measures for the success and effectiveness of PAs. For example in addition to acquiring land for PAs, more cost-effective outcomes for conservation could be achieved if more action were to be taken against specific threats, such as invasive species control or off-reserve management (Wilson et al. 2007).

Little is generally known about PLCA contribution to conservation, mainly with respect to non-formal conservation areas. I therefore investigated the current contribution of the private conservation estate in the Western Cape Province as a case study and assessed potential future influences on PLCAs, both positive and negative. The Western Cape Province provided an interesting study area for addressing these questions due to the diversity of privately owned conservation areas.

I hypothesized that (H0) PLC and in particular non-formal conservation areas can contribute disproportionally to biodiversity conservation because they mainly occur in areas of lower altitudes and gentler slopes where they protect highly relevant and even threatened areas and ecosystems, in comparison to statutory PA networks. Alternatively, (H1) non-formal conservation areas might not strongly contribute to conservation targets because they do not protect substantially different areas than statutory PAs.

Understanding the conservation contribution (current status and future potential) of especially non-formal PLCAs provides insight about their importance towards achieving conservation targets. This represents a source of continuity towards building desired resilience of individual conservation areas and entire networks. It can help to raise awareness for conservation importance in wider society and to create support mechanisms, such as incentives or collaborations. Suitable non-formal PLCAs can potentially either be incorporated into the statutory PA network through formalisation or strengthened by alternative flexible mechanisms, such as Payments for Ecosystem Services based on measures of conservation outcome and ecosystem services provision to society. The importance of achieving conservation targets and the potential occurrence of future influences faced by PLCAs (both positive conditions and threats), which have to be considered, create a need for building adaptive capacity (i.e. innovation). Opportunities for creating continuity, based on the heterogeneity of PLCA approaches, can be identified.

6.1.1 Study Area

PAs and their management in South Africa are defined and manifested in the *National Environmental Management: Protected Areas Act 2003* and the *National Environmental Management: Biodiversity Act 2004*. Both documents distinguish between several categories of statutory PAs: special nature reserves, national parks, nature reserves, and protected environments. They further recognise world heritage sites, marine PAs, specially protected forest areas, and mountain catchment areas. There is an explicit difference between statutory PAs and conservation areas, which are areas of land not formally protected by law but protected by the current owners and users and managed, at least partly, for biodiversity conservation. Conservation areas are not considered a strong form of protection since there is no long-term security associated with them, and thus they are not a major focus of the *National Protected Areas Expansion Strategy*. This strategy calls for an expansion of the conservation estate because nationally the current statutory PA network is not sufficient for target achievement (Department of Environmental Affairs and Tourism 2005; Government of South Africa 2010).

The Western Cape Province is home to seven national parks (SANParks 2015), 47 provincial PAs, of which 27 are accessible for the public (Western Cape Government 2015), and about 260 other governmental PAs, such as wilderness areas and state forests (Figure 1). Statutory PAs protected around 10,000 km² of the province in 2012 (Turner 2012), and protected about 11,202 km2 in 2014 (calculated using the WCBF2014 data sets, SANBI (2016)). Alongside these statutory PAs, numerous PLCAs exist, of which many are formally protected in the Stewardship Programme of the provincial conservation authority CapeNature, however, many are non-formal conservation areas (see section 1.9, Chapter 1). In my assessment I thus distinguish between categories of PLCAs in order to gain insights into the potential contribution of non-formal areas to conservation (Figure 2).

In the Western Cape Province, an expansion of the conservation system is implemented due to strict conservation planning which is based on comprehensive assessments of the current state of biodiversity and PA networks (Turner 2012; Pence 2014). Already implemented programmes are CAPE, STEP and SKEP. Conservation planning in the province is informed by the Western Cape Biodiversity Framework (Kirkwood et al. 2010; Pence 2014). It provides a comprehensive assessment of critical biodiversity areas (CBAs), their dynamics and contribution to conservation targets which represents high importance for protection of ecosystems. Further, the National Vegetation Map of South Africa (version 2009 together with metadata; SANBI (2016)) provides an assessment of the threat status of ecosystems representing the urgency for protection. Based on a combination of information about CBAs and ecosystem threat status, PLCAs can be assessed according to their contribution to conservation targets and strategies. Notably, non-formal PLCAs with high potential for future conservation action can be identified.

National conservation targets for the protection of threatened ecosystems in South Africa are stated as relative measures (percentages) of the original ecosystem extent and 20-year targets vary for each biome (Government of South Africa 2010; Table 2, page 20). The Western Cape Province almost achieved the target already for PA coverage, however, protection status of threatened ecosystems still varies strongly (Government of South Africa 2010, Table 3, page 21; Meyer & Maree 2013). In the Western Cape Province these targets for the protection of threatened ecosystems are converted from relative percentages into absolute targets, i.e. actual area extent (in hectares), for each threatened ecosystem (Kirkwood et al. 2010; Pence 2014). Thus, such a specific assessment to compare current protection versus target protection was beyond the scope of this thesis chapter and comparisons were restricted to overall percentages (PLCAs versus statutory PAs).

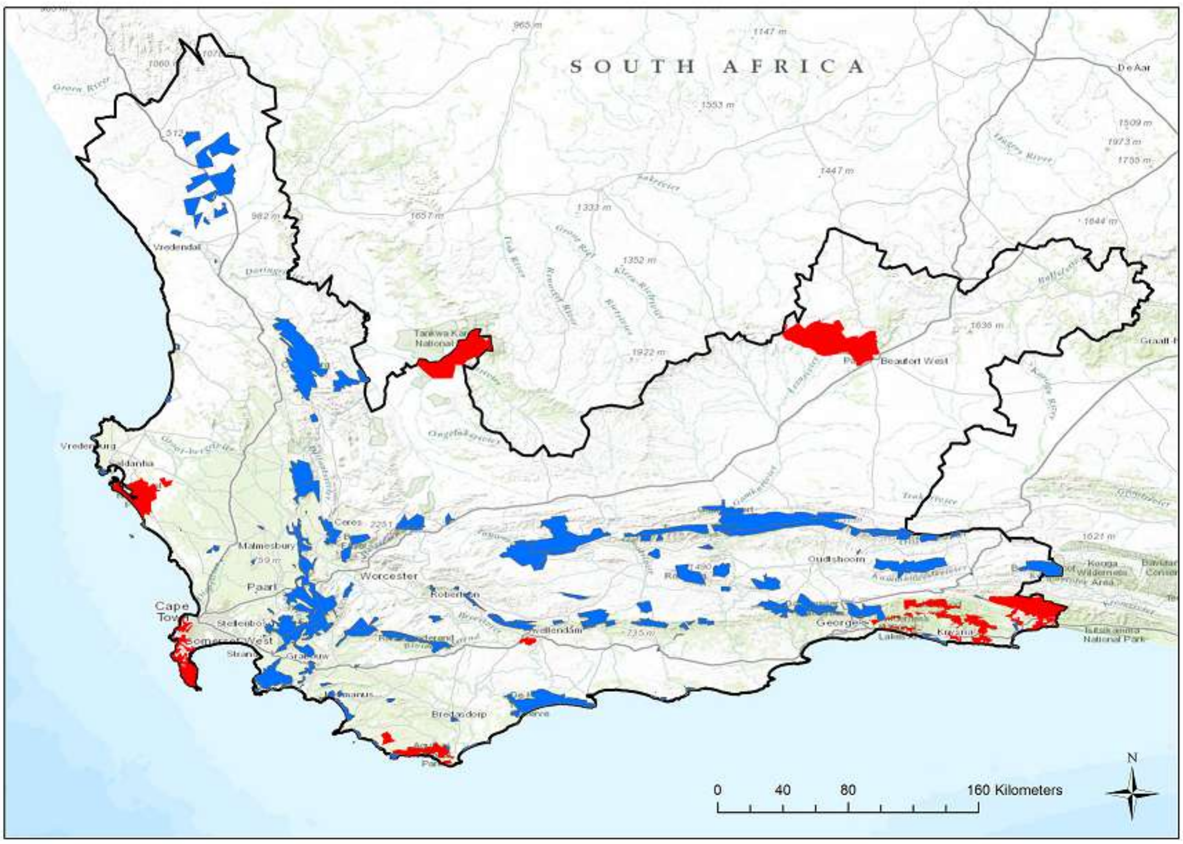


Figure 1: Statutory PAs in the Western Cape Province. National Parks in red, provincial reserves and other governmental areas (e.g. state forests) in blue (data source: WCBF2014 (SANBI 2016)).

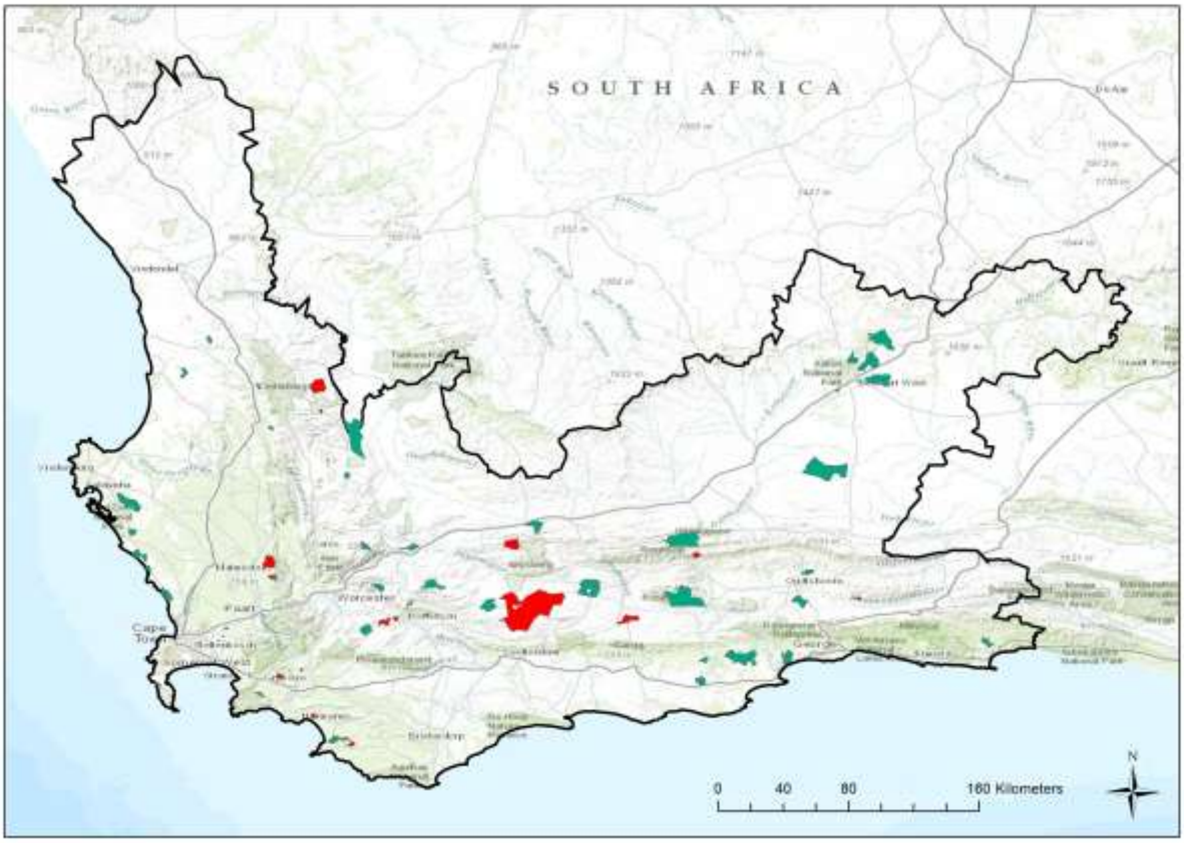


Figure 2: Extent (property sizes) of participating 70 PLCAs in Western Cape Province. Formal PLCAs in red (Stewardship sites: contract reserves, biodiversity agreements, voluntary conservation areas), non-formal PLCAs in green as of CapeNature inventory 2014 (Purnell 2014)

6.2 Data and Methods

6.2.1 Data

Data and property boundaries regarding the assessed PLCAs were derived during personal interviews as described in section 1.9, Chapter 1. The legal status of all PLCAs was verified according to the most recently available inventory of CapeNature Stewardship sites (Purnell 2014). PLCAs were then distinguished throughout the analysis according to their legal protection status into two groups: 1) formal *PLCAs* (representing contract nature reserves, biodiversity agreements and voluntary conservation areas) and 2) non-formal *PLCAs* representing areas without formal protection not being part of the Stewardship Programme. Statutory PAs in the following text refer to all national and provincial PAs.

Several datasets providing spatial information (property boundaries) for statutory PAs in the Western Cape Province were used for spatial analyses, and were obtained from the WCBF2014 (SANBI 2016). These 15 regional datasets (Table 1) of statutory PAs also included formal PLCAs (in the form of contract nature reserves and biodiversity agreements) which were removed from the files and subsequent analysis.

NASA's SRTM90 version 4, which is a Digital Elevation Model at a resolution of 90x90m, was used as the Digital Elevation Model to extract elevation values for PLCAs and statutory PAs (NASA 2015).

Table 1: Datasets used for spatial analyses of area, elevation and slope of statutory PAs in the Western Cape Province (data sources: NASA (2015) and SANBI (2016)). These spatial datasets provided the property boundaries of statutory PAs

Region	*Dataset*
West Coast	PA_Bergrivier
	PA_Cederberg
	PA_Matzikama
	PA_Saldanha
	PA_Swartland
Cape Winelands	PA_Breedevalley
	PA_Drakenstein_Stellenbosch
	PA_Langeberg
	PA_Witzenberg
Eden	PA_George_Knysna_Bitou
	PA_Hessequa
	PA_Kannaland_Oudtshoorn
	PA_MosselBay
Overberg	PA_Overberg
Central Karoo	PA_CentralKaroo
South Africa	SRTM90 v4 (Digital Elevation Model, NASA)

Several datasets for CBAs and threatened ecosystems were used for spatial analyses and were again derived from the WCBF2014 (SANBI 2016). These datasets (Table 2) included 20 regional files providing spatial information on CBA extent in the province as well as a national vegetation map with spatial information on ecosystem extent and corresponding threat status.

It is important to note, that no regional CBA-file was available for the City of Cape Town area and thus three PLCAs of the sample could not be assessed and had to be excluded from further analyses (all non-formal). Same applies to the statutory PAs which fall into this area, they also could not be assessed or compared to the PLCAs of my sample (e.g. Table Mountain National Park). Results need to be interpreted with this limitation.

Table 2: Critical biodiversity area and vegetation datasets used for spatial analyses of PLCAs and statutory PAs in the Western Cape Province (data source: WCBF2014 (SANBI 2016)**). CBA files were used to calculate CBA extent, the vegetation map was used to calculate the extent of threatened ecosystems and to then identify their threat status (metadata file)**

Region	*Name of spatial dataset*
West Coast	CBA_terrestrial_Cederberg
	CBA_terrestrial_Saldanha
	CBA_and_ESA_Swartland
	CBA_terrestrial_Bergrivier
	CBA_and_ESA_terrestrial_Matzikama
Cape Winelands	CBA_terrestrial_Breedevalley_1
	CBA_and_ESA_BreedeValley_2
	CBA_and_ESA_Drakenstein_Stellenbosch
	CBA_terrestrial_Langeberg_1
	CBA_and_ESA_Langeberg_2
	CBA_terrestrial_Witzenberg_1
	CBA_and_ESA_Witzenberg_2
Eden	CBA_and_ESA_George_1_Knysna_Bitou
	CBA_and_ESA_George_2
	CBA_terrestrial_Hessequa
	CBA_and_ESA_Kannaland_Oudtshoorn
	CBA_terrestrial_MosselBay
Overberg	CBA_and_ESA_Overberg_1
	CBA_and_ESA_Overberg_2
Central Karoo	CBA_and_ESA_CentralKaroo
South Africa	vegm2009 (national spatial layer on vegetation coverage)
	WCP_summary_Ecosystem Status Statistics_31March2014 (Excel file with metadata about ecosystem threat status regarding the veg2009 layer)

6.2.2 Analytical Approach

I applied a several-step analysis in order to assess the contribution of PLCAs to biodiversity conservation in the Western Cape Province, in comparison to statutory PAs. Firstly, elevation statistics for all PAs and the entire Western Cape Province were calculated. To do this, I used the SRTM90. In ArcGIS (version 10.0) I extracted elevation values for each raster grid cell for the Western Cape Province, my sample of PLCAs, and the statutory PAs. Subsequently, I calculated mean elevations, created histograms of elevations, and tested for significant differences in mean elevations for all three spatial datasets using a nonparametric Wilcoxon signed rank test in the statistical software R (R Core Development Team 2014). In addition to elevation statistics I calculated mean slope values for all PAs by applying the spatial analytical tool ‘slope’ in ArcGIS. Mean values were then compared with t-tests to assess significant differences between PLCAs and statutory PAs. Slope provides a measure for the topography of PA properties and thus an indication of whether or not areas are located in mountainous regions or not.

Secondly, the overall area representation of CBAs in formal and non-formal PLCAs in comparison to statutory PAs was calculated (representing the importance for protection), using the regional WCBF2014 layers (Table 2). Subsequently, the number of PLCAs incorporating CBAs was identified.

Thirdly, a similar procedure was used to assess the extent and threat status of ecosystems protected by formal and non-formal PLCAs in comparison to statutory PAs (representing the urgency for protection). The veg2009 layer was clipped with the layers of PA property boundaries. Ecosystems and their threat status were then identified using codes provided in the WCBF2014 metadata. Again, the number of PLCAs which protect threatened ecosystems were identified.

Lastly, the resulting layer for protected CBAs was clipped with the layer of protected threatened ecosystems, in order to identify areas of overlap (representing the highest priority according to importance and urgency for conservation action). The extent of overlapping areas protected by formal and non-formal PLCAs, together with the corresponding PLCA numbers, were assessed. Statutory PAs at this point were not assessed anymore since they are already formally implemented.

Future opportunities and threats

Interviewees were asked to name three positive and negative future influences each which could potentially affect PLC as entire conservation system as well as their individual PLCAs . Responses about future influences have been categorized regarding influence types. All responses were assessed using descriptive statistics.

6.3 Results

Legal status, elevation and area of PLCAs

According to the Stewardship inventory for December 2013 (Purnell 2014), 18 PLCAs of my sample were formally protected (13 listed as contract nature reserves, two as biodiversity agreements and three as voluntary conservation areas). The remaining PLCAs of my sample (52) were not currently involved in the Stewardship Programme and fall under the category of 'non-formal' in this analysis.

PLCAs were found to, on average, be situated in areas of lower altitudes and gentler slopes when compared to statutory PAs (Table 3). Differences between both metrics were statistically significant. Furthermore, the mean elevation of the Western Cape Province (594m) was significantly lower than the average elevations of PLCAs ($p < 0.001$) and SPAs ($p < 0.001$).

Table 3: Zonal statistics for private and statutory PAs in the Western Cape Province

Metrics	*PLCAs*	*Statutory PAs*	*p-value*
Mean elevation	660 m	746 m	< 0.001
Mean slope	7.9 degrees	13.6 degrees	< 0.001

Large parts of the Western Cape Province have elevations between 0m and 1000m, with two peaks around 100-200m and 800-900m, respectively (Figure 3). Compared to this range of dominant elevations, statutory PAs were more often situated at the edges of the range. The statutory PA elevation histogram highlights two peaks, one around 0-100m and one with highest densities around 800-1000m. Contrarily, PLCAs had a peak of high densities in areas around 400-500m.

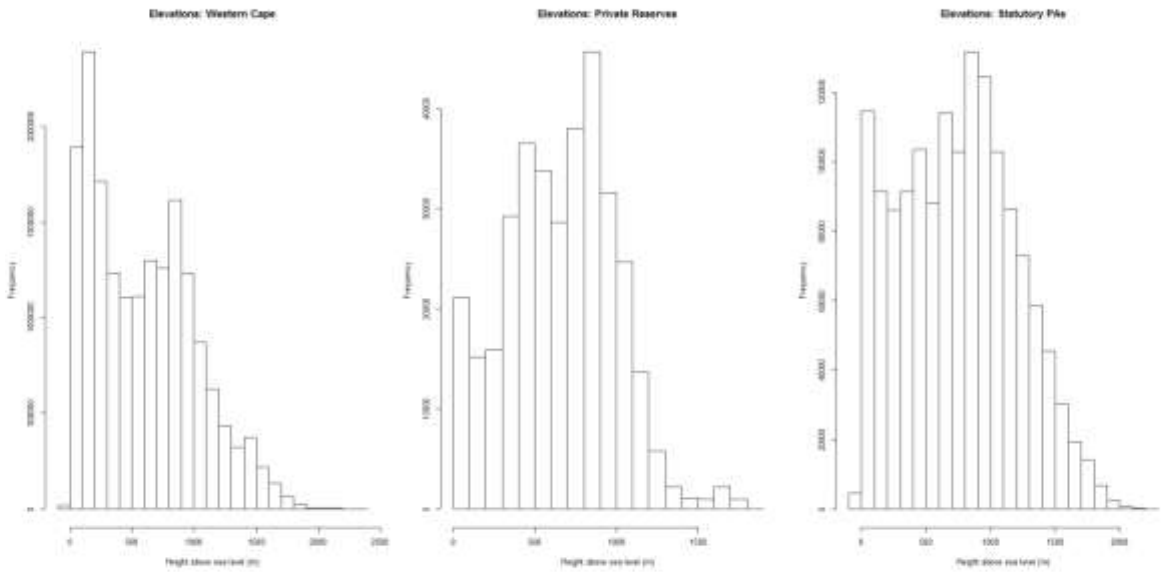


Figure 3: Elevation histograms of the entire Western Cape Province, PLCAs and statutory PAs. The y-axis depicts the number of pixels of a given height

PLCAs covered a total area of around 253,396 ha which is equivalent to about 2% of the Western Cape Province. Formal PLCAs covered approximately 80,832 ha and non-formal PLCAs approximately 172,564 ha.

Statutory PAs, in comparison, covered 1,120,165 ha (= 11,202 km2) which is equivalent to 8.5% of the Western Cape Province (Figure 1). The private conservation estate thus compared to about 22.6% of the total statutory PA network.

Critical biodiversity areas

In total, 58 PLCAs of my sample protected parts of CBAs. All formal PLCAs (18) as well as 45 of the non-formal PLCAs (52 total; 3 not assessed due to lack of spatial datasets for Cape Town) protected CBAs to some extent.

In total, my sample of PLCAs in the Western Cape Province protected 162,244 ha of CBAs. This represents 64% of their total property sizes and 3.6% of total CBAs (4,483,236 ha) designated in the province (Table 4). 36% of these CBAs were protected by formal PLCAs and 64% were contained in non-formal PLCAs. Formal PLCAs showed a slightly higher proportion of CBA protection in relation to their property sizes than non-formal PLCAs. In comparison, statutory PAs in total covered a much lesser extent of CBAs being equivalent to only 6.5% of their property sizes.

Table 4: Extent of critical biodiversity areas protected by the private conservation estate in the Western Cape Province, in comparison to statutory PAs

	Formal PLCAs	*Non-formal PLCAs*	*Total in PLCAs*	*Total in statutory PAs*
CBAs	57,646 ha (71% of formal PLCA property sizes)	104,598 ha (61% of non-formal PLCA property sizes)	162,244 ha (64% of total PLCA property sizes; 3.6% of total CBAs in province (4,483,236 ha))	72,326 ha (6.5% of total statutory PA sizes; 1.6% of total CBAs in province)

Threatened ecosystems

Altogether, my sample of PLCAs in the Western Cape Province covered 43,161 ha of ecosystems of higher threat status (equivalent to 17% of their total property sizes; equivalent to 1.3% of total threatened ecosystems in province), namely vulnerable, endangered and critically endangered ecosystems (Table 5). Formal PLCAs protected 12.6% of these threatened ecosystems and non-formal PLCAs protected 87.4%. Non-formal PLCAs contributed a higher proportion of threatened ecosystems in relation to their property sizes (22%) than formal PLCAs (6.7%). Statutory As, in comparison, protected threatened ecosystems representing 9% of their total property sizes.

Table 5: Extent and threat status of ecosystems protected by the private conservation estate in the Western Cape Province, in comparison to statutory PAs

Threat status	*Formal PLCAs*	*Non-formal PLCAs*	*Total in PLCAs*	*Total in statutory PAs*	*Total in province*
Total (CR + EN + VU)	5,437 ha (6.7% of formal PLCA property sizes)	37,724 ha (22% of non-formal PLCA property sizes)	43,161 ha (17% of total PLCA property sizes; 1.3% of total in province)	102,077 ha (9% of total statutory PA sizes; 3% of total in province)	3,357,594 ha (26% of province area)
Critically Endangered (CR)	5,163 ha	3,297 ha	8,460 ha	14,724 ha	1,575,251 ha
Endangered (EN)	0 ha	20,124 ha	20,124 ha	19,180 ha	737,794 ha
Vulnerable (VU)	274 ha	14,303 ha	14,577 ha	68,173 ha	1,044,549 ha
Least Threatened (LT)	75,394 ha	134,771 ha	210,165 ha	1,010,095 ha	9,472,097 ha

Overlap of critical biodiversity areas and threatened ecosystems

PLCAs in the Western Cape Province protected 24,738 ha of areas with overlap of CBAs and ecosystems with higher threat status (equivalent to 9.8% of their total property sizes) (Table 6). Non-formal PLCAs again protected a higher proportion of these areas in relation to their total property sizes (12%) than formal PLCAs (4%). In total, eight formal PLCAs (representing 44% of formal PLCAs) and 22 non-formal PLCAs (42% of all non-formal PLCAs) protected overlapping areas of threatened ecosystems and CBAs (Figure 5). Of the non-formal PLCAs, ten protected critically endangered CBAs (CR), nine protected endangered CBAs (EN) and 15 protected vulnerable CBAs (VU).

Table 6: Extent of threatened ecosystems overlapping with critical biodiversity areas as protected by the private conservation estate in the Western Cape Province

Threat status of CBAs	*Formal PLCAs*	*Non-formal PLCAs*	*Total in PLCAs*
Total (CR + EN + VU)	3,566 ha (4% of formal PLCA sizes)	21,172 ha (12% of non-formal PLCA sizes)	24,738 ha (9.8% of total PLCA sizes)
Critically Endangered (CR)	3,448 ha	1,742 ha	
Endangered (EN)	0 ha	10,284 ha	
Vulnerable (VU)	118 ha	9,146 ha	
Least Threatened (LT)	54,131 ha	78,445 ha	

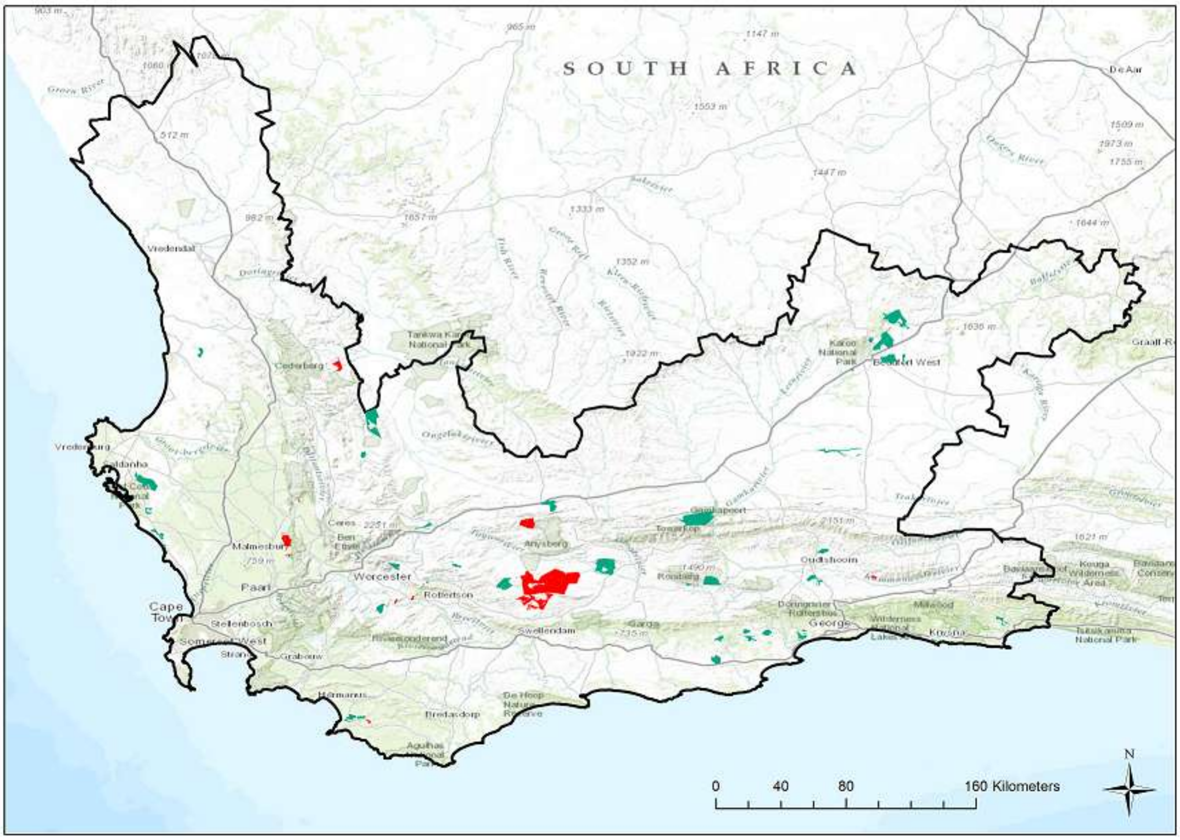


Figure 6: Formal (red) and non-formal (green) PLCAs which protect both critical biodiversity areas and ecosystems of high threat status in the Western Cape Province

Future Opportunities and Threats to Private Land Conservation in the Western Cape Province

Positive future influences

When asked to name three positive future influences on their PLCAs, owners and managers stated these positive influences to be of rather socio-economic type (121 responses) than to be of ecological type (70 responses). Sixteen interviewees did not state a total of three responses each, however, 77% of interviewees provided three responses. Many interviewees named two or three positive influences to be socio-economic, whereas ecological positive influences rather occurred in singular or not at all (Figure 7).

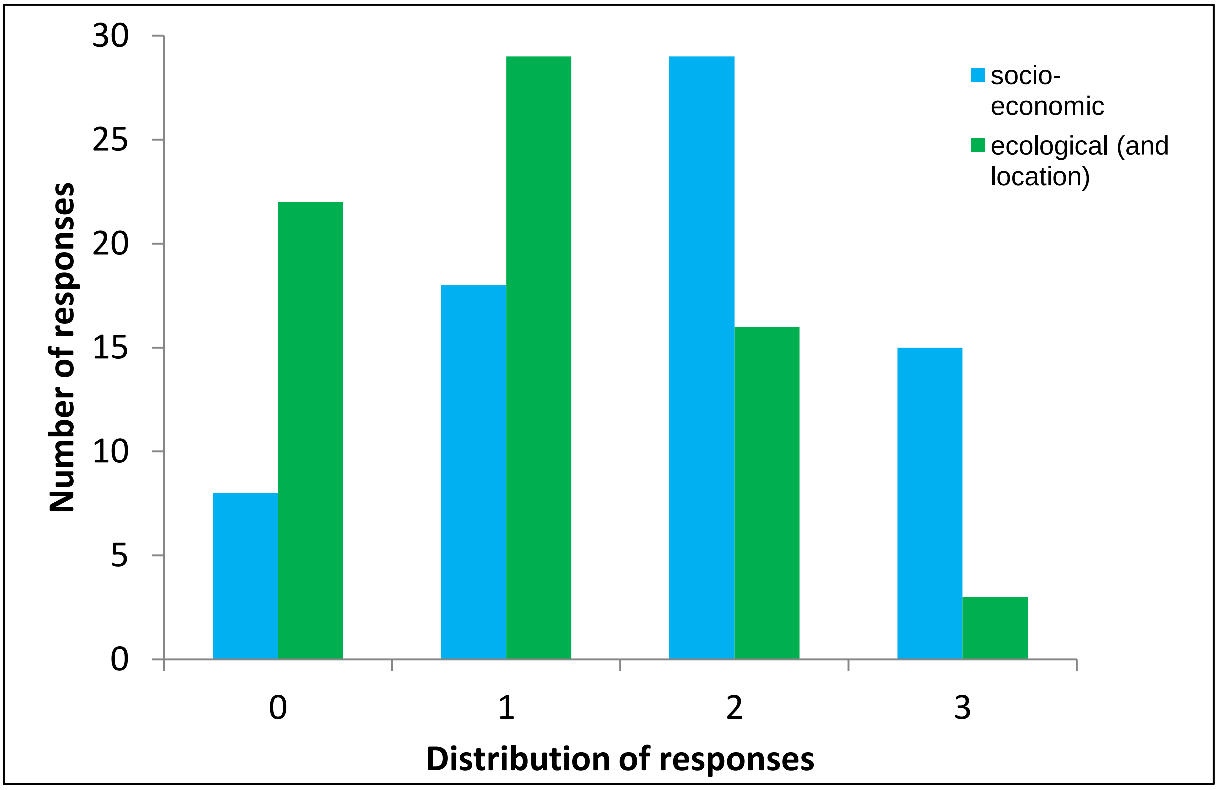


Figure 7: Distribution of positive future influences on PLCAs, being either socio-economic or ecological. Study participants provided up to three responses each. (Original interview question: 'Which are the 3 most important positive influences / conditions on your park?'; General Questionnaire)

The main type of positive influences, representing socio-economic factors, was internal values (such attitude of owner, good staff and sustainable business approach). Other types of positive socio-economic influences were less important: external societal and cultural values (such as growing awareness for conservation); tourism (overall tourism dynamics); economic (such as independent income, growing regional economy, currency exchange rate), collaboration (being part of Stewardship programme, research) and political (such as legislation, safety) (Figure 8).

The most important type of positive influences which rather represented ecological factors was biophysical conditions (such as rainfall, water availability, soil conditions), followed by flora, fauna, location (i.e., proximity to Cape Town, accessibility) and scenic (e.g. beauty, open space) (Figure 9).

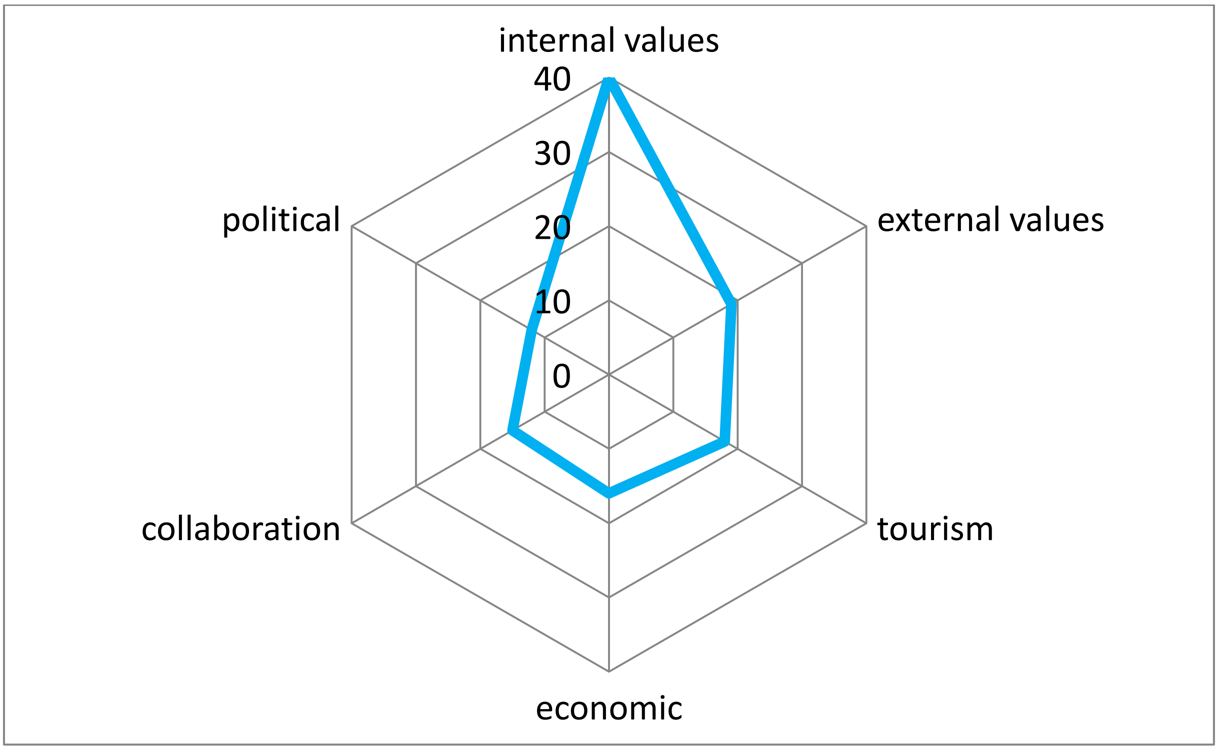


Figure 8: Positive future socio-economic influences on PLCAs as stated by owners and managers. Internal values represent e.g. attitude of owner, good staff and sustainable business approach.

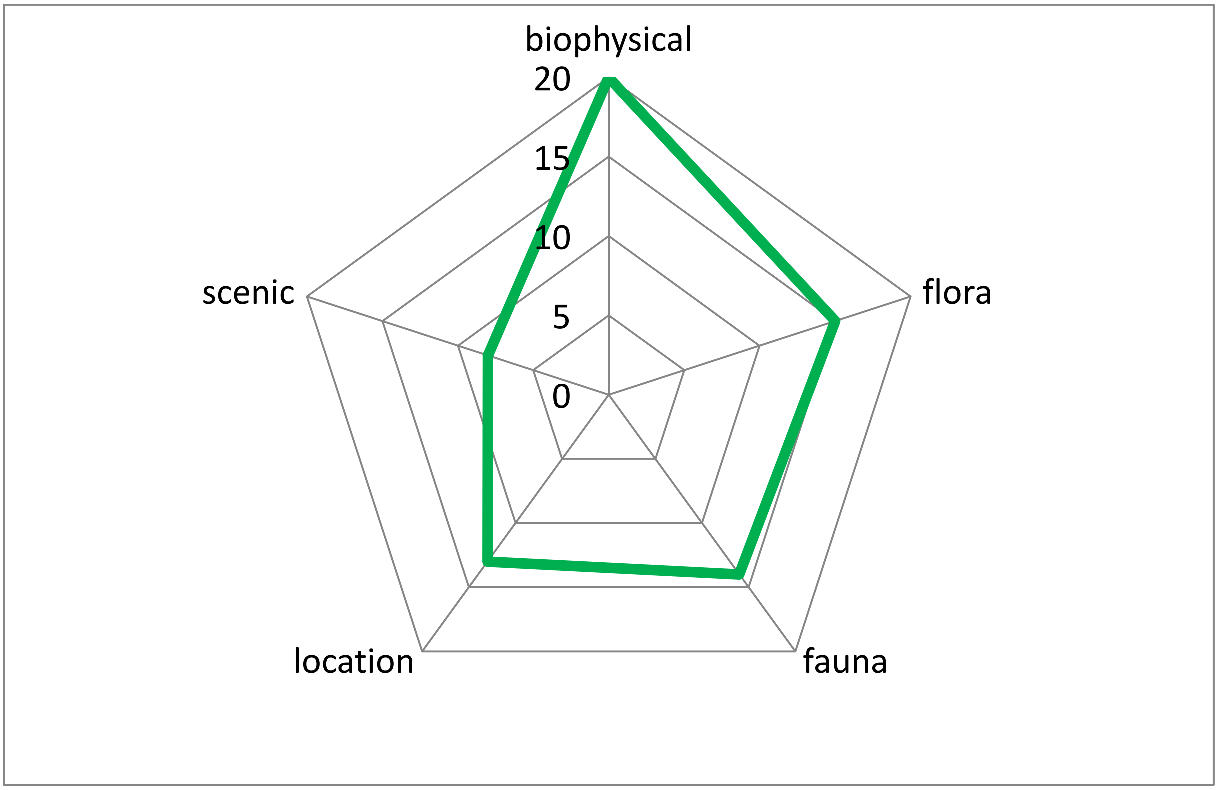


Figure 9: Positive future ecological influences on PLCAs, as stated by owners and managers. Biophysical represent e.g. rainfall or soil conditions.

Negative future influences

When asked to name three negative future influences on their PLCAs, owners and managers stated these negative influences to be rather of socio-economic type (120 responses) than of ecological type (52 responses). 25 interviewees did not provide three responses, but 64% did. Many interviewees many PLCAs named two to three positive influences to be socio-economic whereas many named only one or no ecological negative influences (see Figure 10).

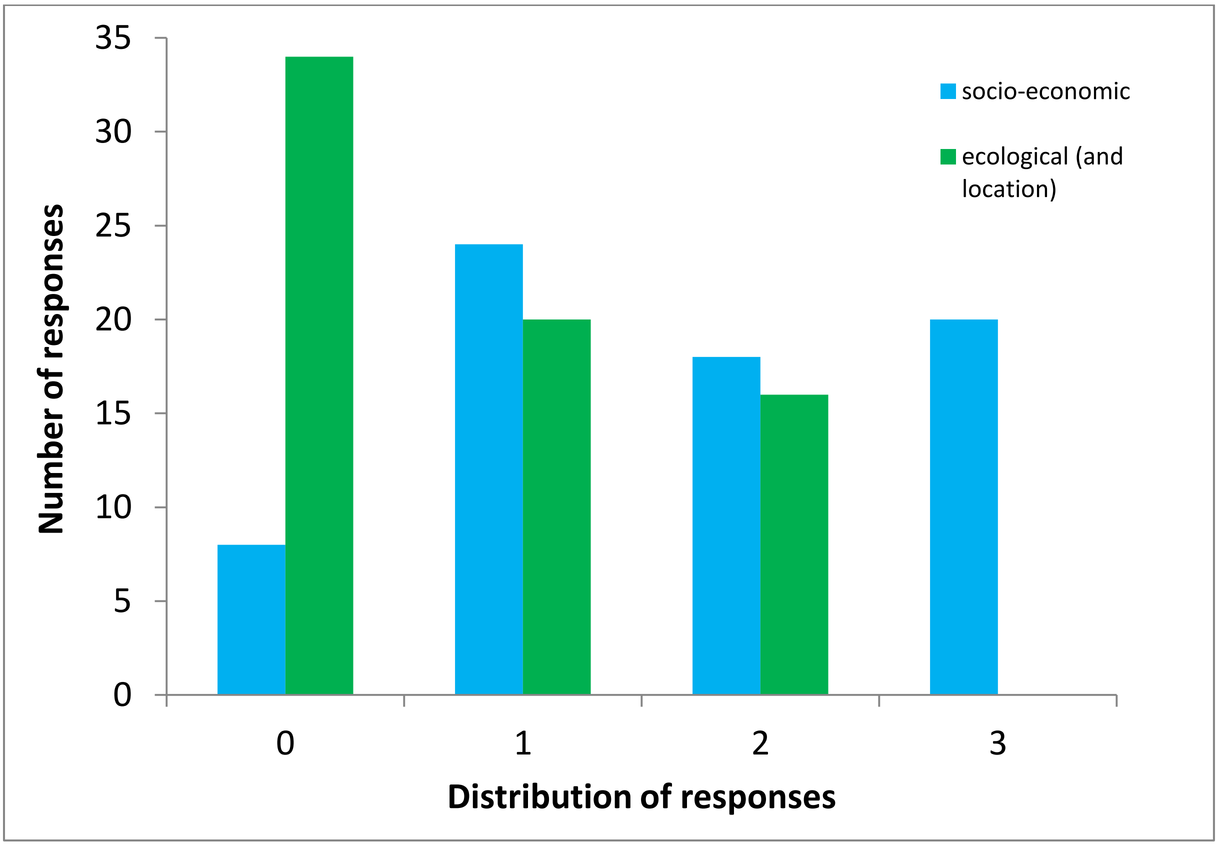


Figure 10: Distribution of negative future influences on PLCAs, being either socio-economic or ecological. Study participants provided up to three responses each. (Original interview question: 'Which are the 3 most disturbing influences / threats on your park?'; General Questionnaire)

The main type of negative influences representing rather socio-economic factors was political (e.g., safety, legislation, land claims, mining and fracking). Other types of socio-economic negative influences were much less important: external values (such as public awareness for conservation, conservation ethics in wider society), economic (recession, land prices, financial viability of reserve), collaboration (no governmental support, overregulation of sector, lack of capacity), internal values (service quality, lack of expertise), tourism (overall dynamics) (Figure 11).

The two most important types of negative ecological influences were fire (fear of too frequent or large wildfires) and climate (climate change, floods, droughts) (Figure x). Other types of negative ecological influences were less important: flora, fauna, human disturbances (poaching, overexploitation, domestic animals) and tourism (overall dynamics).

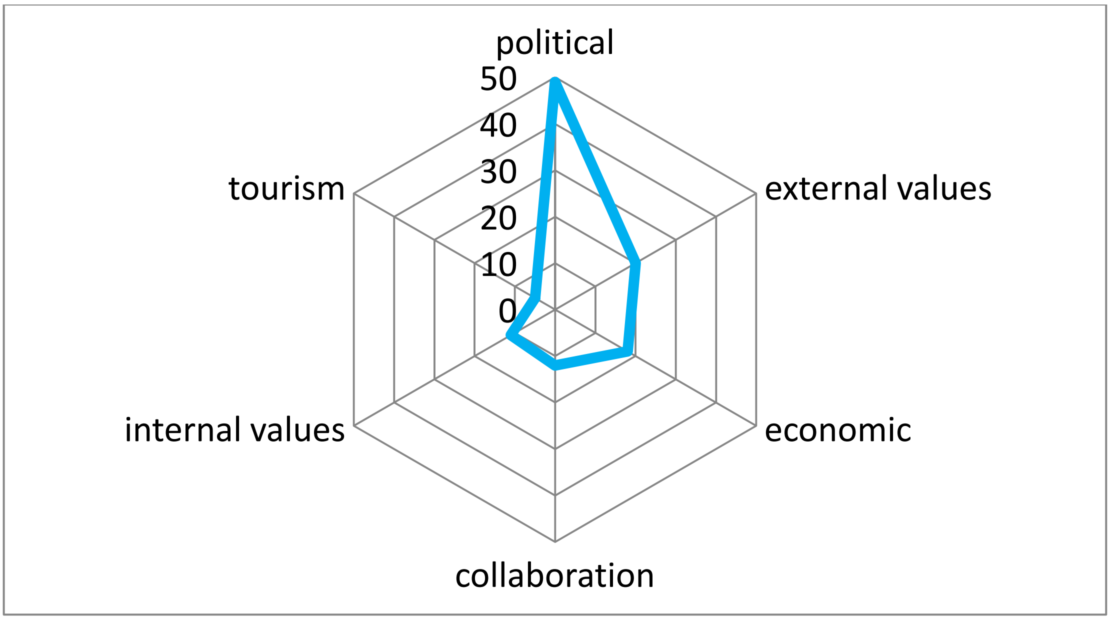


Figure 11: Negative future socio-economic influences on PLCAs, as stated by owners and managers. (Political factors represent e.g. safety, legislation, mining)

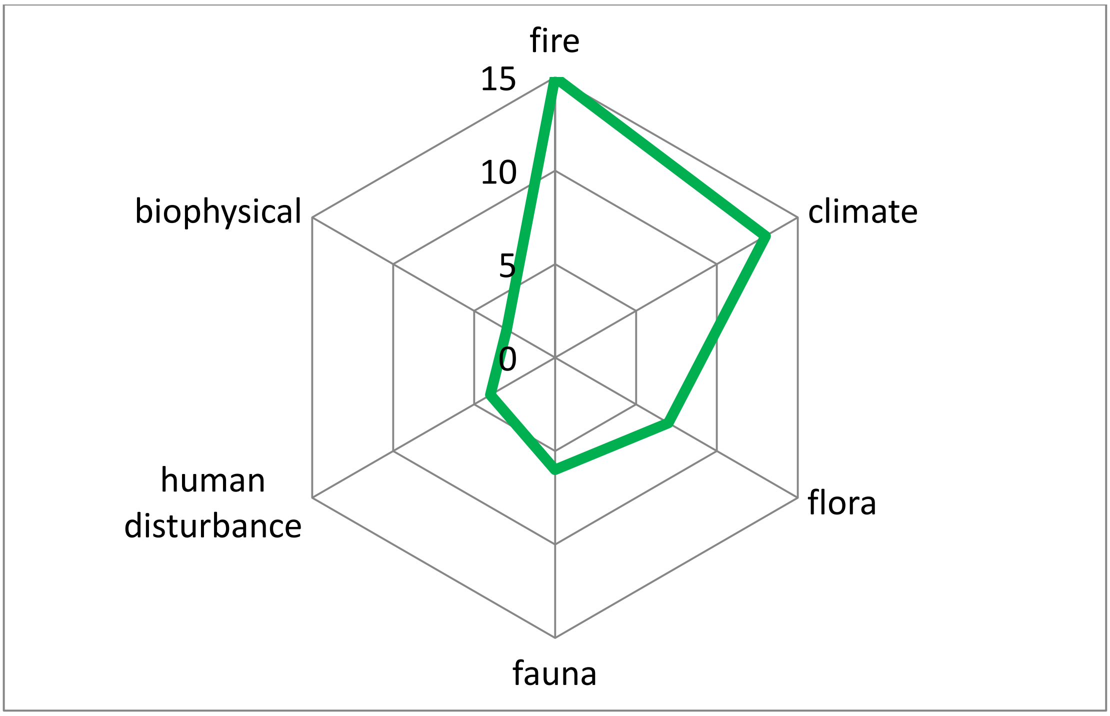


Figure 12: Negative ecological future influences on PLCAs, as stated by owners and managers. (Climate represents climate change, floods and droughts. Human disturbance represents e.g. fragmentation or overexploitation of recourses.)

When asked whether or not future influences (both positive and negative) are expected to change, 35 interviewees responded with 'no' and 35 responded with 'yes'. The interviewees who expected future influences to change were mostly pessimistic and responded that conditions will become worse for PLC (24 responses). Only five interviewees expected conditions to improve and seven stated the nature of change to be depending on the type of influences. Overall, this highlights that the majority of landowners and managers were concerned about future PLC conditions.

6.4 Discussion

PLCAs in the Western Cape Province were located significantly more often in areas of lower altitudes and gentler slopes than statutory PAs. PLCAs showed a density peak for elevations around 400-500m. They thus covered areas of the Western Cape Province which were less represented by statutory PAs (being biased towards lower and higher elevations). Further, PLCAs showed to be important for the protection of both CBAs and threatened ecosystems.

PLCAs altogether protected CBAs equivalent to 64% of their total property sizes and protected about double the extent compared to statutory reserves. Further, PLCAs protected threatened ecosystems equivalent to 17% of their total property sizes and hereby contributed to about half of the extent provided by statutory PAs. In comparison, statutory PAs covered smaller proportions of CBAs and threatened ecosystems in relation to their total property sizes.

Notably, I found considerable differences in conservation contribution determined by PLCA type. Formal PLCAs, incorporated in the Stewardship Programme, are clearly focused on critically endangered ecosystems. Non-formal PLCAs, which are not yet incorporated into official inventories, nevertheless provided a substantial contribution to conservation. They offered a balanced protection among all levels of ecosystem threat status (critically endangered, endangered and vulnerable) and also covered a larger area than formal PLCAs in relation to their property sizes. Overall, 48% of non-formal PLCAs protected areas representing CBAs and ecosystems with high threat status simultaneously.

My findings highlight that PLC is important in three regards, as was also found by studies in other countries (Pressey et al. 2000). Private reserves 1) provide an increase of absolute area extent for conservation, 2) they protect different habitats than statutory PAs and 3) they protect ecosystems of high threat status. Based on these findings, I could verify my null-hypothesis which stated that PLC and in particular non-formal conservation areas can contribute disproportionally to biodiversity conservation because they mainly occur in areas of lower altitudes and gentler slopes than statutory PAs where they protect highly relevant and even threatened areas and ecosystems.

The substantial contribution to conservation, based on importance (CBAs) and urgency (threatened ecosystems), in comparison to statutory PAs can be perceived as a source of continuity for PLCAs. Top-down, governmental authorities and other stakeholders may be forced to pay more attention to these areas and to offer increased support to ensure conservation action. Bottom-up, knowledge about their conservation contribution and related acknowledgement may foster awareness and motivation among landowners to strengthen conservation efforts. Both approaches can lead to long-term persistence and improvement of PLC.

In total, my sample of 70 study participants together protected a land area equivalent to around 22% of statutory PA property sizes. This high representation of PLCAs in the province might be driven by several factors: the long-term strength of conservation ethics in South Africa; the profitability of ecotourism and game hunting; and the decreasing profitability of agricultural activities (Beinert 2003; Archer 2004; Sims-Castley et al. 2005). In light of the total estimated 250-300 PLCAs or even just the 115 designated Stewardship sites, the high relevance of private conservation action for the Western Cape Province becomes apparent.

My findings confirm global patterns, where statutory PAs are often biased towards marginal areas and not sufficient for achieving conservation targets partly because they had been established with differing objectives prior to concurrent management philosophies (Pouliquen-Young 1997; Runte 1997; Joppa & Pfaff 2009). Although many studies of private conservation do not explicitly distinguish reserve groups due to their legal status as I did, private reserves commonly show strong potential to serve as a supplementary solution to statutory PA networks, both in South Africa and globally (e.g. Barnard et al. 1998; Fitzsimons & Wescott 2001; Child et al. 2013). Expanding the statutory PA network towards lower elevations or highly productive lands is often difficult for governmental authorities due to high acquisition costs, opportunity costs to society and management costs (Frazee et al. 2003).

In many regions of the world, PLCAs were found to be relevant and supplementary to statutory PA systems. In Finland, for example, woodland key habitats are privately owned forest patches, protected formally or through good practice, which are highly relevant for the connectivity of the forest PA network alongside traditional reserves (Laita et al. 2010). In Nepal, participatory management programmes and community forests are capable of halting or even reversing trends in deforestation and forest fragmentation (Nagendra et al. 2008). Similarly, Fitzsimons & Wescott (2008) found private land to enhance protection of some ecosystems in Australia and thus argued that "multi-tenure reserve networks have the potential to provide increased knowledge and understanding to conservation planning decision making processes". In Ecuador, the national conservation incentive programme could focus on indigenous areas and communal lands, outside statutory reserves, to refine the deforestation targets for protection of the Amazonian forests (Holland et al. 2014).

Despite their abundance, PLCAs and in particular non-formal conservation areas are rarely considered for achieving conservation targets yet (West et al. 2006; Stolton et al. 2014). Concern has been raised that the private conservation estate is a fragmented and potentially ill-informed mosaic of management practices (Mir & Dick 2012) due to issues of restricted access, diversified policies (based on differing motivations and land uses) and the fear of land owners triggering legal restrictions and reductions in property value. Contrarily, PLCA networks were found to be supportive of a viable landscape due to their heterogeneous management systems (Child et al. 2013). Findings of my research strengthen the positive arguments, because participants in my study, mostly not formally protected, stated high commitments towards conservation objectives and land protection and the majority of PLCAs in the Western Cape Province have existed for many years and land owners intend on expanding rather than selling property (see results in Chapter 2). With growing human populations and increasingly utilised landscapes, however, conservation cannot only consider priority areas due to their suitability or urgency for protection. Conservation planning needs to incorporate the identification of areas which are available for the implementation of conservation action. Therefore, authors such as Knight et al. (2010) and Raymond & Brown (2011) call for an investigation of conservation opportunity. Conservation opportunity will finally allow for specific action being implemented effectively and the research-implementation gap to be bridged. Whittaker et al. (2005) also argue that conservation biogeographers should provide alternative scenarios addressing differing end goals and should investigate the sensitivity of outcomes to different societal objectives.

To achieve participation in top-down approaches, e.g. via the Stewardship Programme of CapeNature, several aspects of the conservation opportunity concept are relevant for the private conservation estate. Participation, and thus conservation opportunity, is determined by the landowners' attitudes and their willingness to participate, cooperate or collaborate. In Poland, for example, landowner attitudes were found to be influenced by three factors, namely knowledge, concern and experience. Furthermore, better policy support, stronger collaboration among stakeholders and more financial or compensatory support affected feasibility of private conservation (Kamal & Grodzinska-Jurczak 2014). Similarly, Selinske et al. (2014) found that "understanding the relationship between motivations, satisfaction, and commitment is necessary for a successful retention strategy in any conservation programme, particularly on private lands" when they investigated participation of landowners in the provincial Stewardship Programme of the Western Cape Province. Considering the substantial contribution of non-formal areas to conservation in the Western Cape Province, an immediate need seems to arise to assessing the willingness of respective landowners to participate and collaborate in more coordinated conservation action.

In light of the many challenges faced by statutory conservation approaches in developing countries, such as underfunding of PAs (Bruner et al. 2004), it is questionable whether top-down concepts and the focus on conservation legislation should be the main way forward. Formal protection 'in perpetuity' does not guarantee biodiversity conservation since even officially gazetted PAs are subject to downsizing or downgrading (Mascia & Pailler 2010). Jurisdictional definitions are not necessarily a good predictor of biodiversity outcomes or conservation motivation. Other potential approaches, which also receive increasing attention, can strengthen conservation across landscapes bottom-up. Via mechanisms such as knowledge sharing, creating bridging organizations, adaptive management concepts, addressing future threats and risk concerns or provision of incentives by authorities and other stakeholders (such as payments for ecosystem services, tax breaks, construction allowances, support in invasive species control or acknowledgement of success amongst many more) the establishment of different PA corporate models and the organic growth of PA networks across landscapes can be fostered. For example, Ostrom & Nagendra (2007) argued that tenure alone is not sufficient to secure the protection of forests. Monitoring and sanctioning is important and will only be effective when users are engaged in decision making and focus is not just placed on formal ownership of areas. Grantham et al. (2010) stated that both passive and active adaptive learning should be viewed as essential in conservation plans for improving future management decisions. Such mechanisms represent sources of innovation for PLC. They offer potential solutions for maintaining and expanding PLCA networks. Especially addressing future threats and risk concerns as potentially faced by owners and managers of PLCAs contributes to the awareness about and possible avoidance of disturbances or even failure in PLCAs, and thus strengthens continuity. Notably, study participants stated that socio-economic threats, such as dynamics in global tourism or societal values, are most feared as compared to ecological disturbances. This highlights that PLC is strongly driven by socio-economic factors of which many function on broader scales and longer timeframes. Such factors can only be accounted for through collaboration and participation.

Chapter 7: Discussion and Conclusion

In my social-ecological, comparative and spatially explicit approach, I holistically assessed the identity of Private Land Conservation Areas (PLCAs) in the Western Cape Province of South Africa. The investigation was based on the four elements of system identity: components; relationships; sources of continuity; and sources of innovation (Cumming & Collier 2005; Cumming 2011; De Vos et al. 2016a). Protected areas (PAs), as social-ecological systems (SESs), can be characterised as resilient when they are able to maintain their identity in space and time against the influence of disturbances (Cumming & Collier 2005; Cumming 2011; Palomo et al. 2014). The long-term functioning and persistence of PLC thereby relies on a better identification and understanding of drivers determining private reserve identity.

At the landscape level, spatial heterogeneity of ecological conditions (e.g. soil properties, rainfall patterns and species distributions) and socio-economic factors (e.g. built infrastructure, legislative systems and financial markets) creates diversity of structures and processes, for example diversified PA models or dynamics in ecotourism. This diversity is important for the resilience of both ecological and social systems as it constitutes the potential for adaptive capacity in these systems (Norberg & Cumming 2008; Biggs et al. 2015). Notably, the relation of social and ecological system properties to space is of importance (Cumming et al. 2010), i.e. interactions and interdependencies between factors and systems caused by and manifested in spatial heterogeneity. I therefore applied the concept of spatial resilience to my assessment of PLCA identity by investigating the importance of geographical factors (such as vegetation units and infrastructure) and the interaction of PLCAs across the landscape. Understanding the influences of space allows for the design and implementation of locally applicable mechanisms for biodiversity conservation and ecosystem management. In my research, the available data did not allow for a solid assessment of dynamics and trends over time, however, provided valuable insight into current patterns of the *status quo* of PLC networks. My findings highlight that PLCA identity is substantially influenced by geographical location and spatial variation in both socio-economic and ecological factors, for example by determining the corporate model (game versus habitat reserves) or by determining visitation rates.

The following sections discuss 1) individual elements of PLCA identity, 2) influences of geographical location on PLCA identity, 3) how PLCA identity can be maintained and desired resilience created, 4) assets and drawbacks of the identity approach for assessing PLC and 5) implications of my findings as well as scope for future research.

7.1 The Four Elements of PLCA Identity

Before addressing representative measures of individual identity elements, main PLCA characteristics were identified and put into context. I conducted a general assessment of the historical background and current situation relating to PLC in the Western Cape Province of South Africa (Chapter 1 and Chapter 2). South Africa has a long-term history relating to private and commercial use of wildlife as well as a strong conservation ethic (Beinert 2003; Bond et al. 2004; Carruthers 2008; Brooks et al. 2011). The country is home to countless privately owned properties involved in game ranching, wildlife breeding, ecotourism, and biodiversity conservation. Yet, no accurate national inventory of PLCAs exists and their role in conservation is not fully understood. Furthermore, both internationally and locally, consistent definitions and terminology for PLC are still lacking and not used accurately (Carter et al. 2008; Stolton et al. 2014). My investigation showed that the Western Cape Province was no exception. PLCAs in this province were found to represent a wide range of characteristics and contexts, such as size, age, ecological features or economic conditions (Chapter 2). They furthermore faced similar opportunities as well as challenges when compared to PLCAs across the globe. A fundamental finding highlighted that PLCAs in the Western Cape Province differed among each other due to a unique characteristic, namely whether or not large mammals were stocked on the property and guided drives offered. Alongside PLCAs, which stocked large mammals and hosted safari-type ecotourism, many PLCAs existed which instead focussed on indigenous flora and fauna as an ecotourism draw-card as opposed to large mammals.

The pattern of whether or not PLCAs stocked large mammals and offered safari-type ecotourism raised the question of whether or not distinct PLCA types existed in the province. I subsequently investigated this by focusing on PLCA identity based on system components, as the first element of identity (Chapter 3). My studies proved that two PLCA types, namely game and habitat reserves, were found, which differed significantly in several components. Most assessments of PLC worldwide have thus far focused on single components, such as whether or not income was generated on the property (Moon & Cocklin 2011) or property sizes and property rights (Tecklin & Sepulveda 2014). My investigation was more comprehensive and focussed on both socio-economic and ecological variables.

Following the assessment of SES components, I explored the relationships in socio-economic PLC networks, as representative measure of the second identity element (Chapter 4). Interaction took place both in close proximity and in communities relating to specific topics, mainly charismatic species. Overall, networks among PLCAs as well as other stakeholders in the province showed a lack of collaboration across scales suggesting a strong potential for enhancement. In conservation, network analysis is a useful tool to understand PA networks (Mills et al. 2014) which is relevant since they are dynamic and change over time (Lauber et al. 2011). Furthermore, collaboration is important to exchange information and to enhance the outcomes of conservation. In coastal Oregon in the USA for example, Vance-Borland & Holley (2011), found stakeholder groups in natural resource management to be isolated and thus involved participants in actively facilitating network change (i.e. creating new relationships to enhance outcomes by introducing people with common interests, implementing an online participant skills directory, a grant proposal and collaboration between local and state actors).

With respect to sources of continuity, as the third identity element, I assessed the drivers explaining variation in visitation to PLCAs. Visitation serves as representative measure for ecotourism which is one potential option for building future economic viability and thus persistence of PLC (Chapter 5). A combination of factors, representing ecological, infrastructural, and location variables, determined variation in visitation rates to PLCAs in the Western Cape Province. The number of large mammals, presence of Big 5-species, number of provided facilities and average accommodation charges emerged as important individual factors for explaining variation in visitation. Generally, factors driving high visitation rates resembled the main characteristics of game reserves. Therefore the adopted corporate model of game reserves appears to substantially explain variation in visitation rates in PLCAs of the Western Cape Province, but this does not mean that habitat reserves do not provide important cultural ecosystem services. Charismatic species were found to be tourist attraction factors for PLCAs in other regions but are not necessarily beneficial for PLC ecotourism success and biodiversity conservation by possibly impacting indigenous flora and fauna and straining the economic conditions of reserves (Di Minin et al. 2013; Maciejewski & Kerley 2014a). This argument was supported by my findings which showed that visitors value Big 5-species less important than vegetation or birds, as perceived by PLCA owners and managers.

Contribution of PLC to biodiversity conservation in the Western Cape Province was investigated by assessing the spatial coverage of critical biodiversity areas and threatened ecosystems in PLCAs and discussed in light of potential threats and disturbances as faced by PLCAs (Chapter 6). With this approach I assessed both the importance and urgency of areas for conservation action and why PLC is a potentially important option for conservation in the Western Cape Province. Incorporating both importance and urgency into investigations is increasingly common (e.g. Newburn et al. 2005). Contribution to conservation and the potential threats and disturbances faced by PLCAs speak to sources of continuity as well as sources of innovation, as the fourth identity element, by creating a need (i.e. innovation) as well as insight about options (i.e. continuity) for enhanced and new conservation approaches.

PLCAs, of both formal and non-formal status, contributed substantially to the protection of critical biodiversity areas as well as ecosystems with high levels of threat (Table 1). In particular conservation areas which were not yet incorporated into governmental programmes represented an important potential target for future conservation planning and the development and implementation of new strategies in the Western Cape Province. Although seldom explicitly distinguished according to legal status, PLCAs in general were found to offer substantial contribution to statutory conservation estates worldwide which tend to occur in areas of marginal land, high altitudes and low threats of land-use change (Pressey et al. 2000; Joppa & Pfaff 2009; Child et al. 2013). These findings raise the need for a discourse around whether statutory conservation is a future solution or whether mechanisms should be focusing on dynamic conservation outcomes instead.

Table 1: Conservation contributions of PLCAs and statutory PAs in the Western Cape Province

	Formal PLCAs	*Non-formal PLCAs*	*PLCAs total*	*Statutory PAs*	*Western Cape Province*
CBAs	71% of total property sizes	61% of total property sizes	64% of total property sizes; 3.6% of total CBAs in province	6.5% of total property sizes; 1.6% of total CBAs in province	4,483,236 ha
Threatened Ecosystems (CR, EN, VU)	6.7% of total property sizes	22% of total property sizes	17% of total property sizes; 1.3% of total extent in province	9% of total property sizes; 3% of total in province	3,357,594 ha; 26% of total province area
CBAs and threatened ecosystems combined	4% of total property sizes	12% of total property sizes	9.8% of total property sizes		

7.2 The Influence of Geographical Location on PLCA Identity

All elements of PLCA identity were substantially influenced by geographical location and spatial variation in social-ecological factors. The first element, namely system components, differed significantly among PLCAs according to their biophysical context. The biophysical context determined an existing PLCA typology in the Western Cape Province, which distinguished game and habitat reserves from one another (Chapter 3). The dominant biome played a major role for the adopted corporate model of whether or not large mammals were kept on the property. Habitat reserves were more commonly found inside of the Fynbos biome compared to game reserves. This finding might not necessarily be surprising because Fynbos habitats are attractive for many outdoor activities (e.g. hiking, biking) and often less suitable for many charismatic species (i.e. safari-type ecotourism of game reserves). However, also habitat reserves in the karoo and other areas are in demand and thus the significance of the distribution of PLCA types is not self-evident.

Game and habitat reserves also differed with respect to interaction networks, representing relationships as the second identity element (Chapter 4). Collaboration among game reserves was dominated by membership in sub-networks relating to common topics of interest. This means that communication took place between PLCAs stocking charismatic species or being involved in hunting and wildlife trade, regardless of proximity of properties. Habitat reserve networks, in comparison, showed a strong neighbourhood effect producing local clusters of interactions. This neighbourhood effect was also significant for overall PA networks when not distinguished according to the typology. Spatial factors such as close proximity accounted for enhanced collaboration and were generally rated as an important driver for interaction by landowners and managers of PLCAs.

Spatial heterogeneity in both ecological (e.g. presence of mammal species) and socio-economic factors (e.g. facilities provided) furthermore explained a large portion of variation in visitation rates to PLCAs in the Western Cape Province (Chapter 5). Visitation was used as a measure of ecotourism, representing a potential for creating or maintaining economic viability in PLCAs and thus a source of continuity (third identity element). Accessibility and internal infrastructure were important for attracting many visitors, representing more socio-economic factors of location since they are driven by demand and supply, human-induced management and investment. Importantly, the presence of Big 5-species generally represented the adopted corporate model of game reserves, as defined in Chapter 3. This finding directly linked back to the trend whereby the dominant biome determined PLCA typology, representing a more ecological driver of location.

Ecological drivers of location further determined the contribution of PLCAs to biodiversity conservation in the Western Cape Province and socio-economic disturbances posed possible future threats, representing both sources of continuity and innovation as the fourth identity element (Chapter 6). PLCAs occurred significantly more in areas of lower elevations and gentler slopes when compared to statutory PAs and with respect to the topographical context across the entire province. They thus provided a substantial contribution to conservation by covering critical biodiversity areas and protecting threatened ecosystems. This contribution and the future threats faced by PLCAs create the need (i.e. innovation) as well as insight for options (i.e. continuity) for the design and implementation of enhanced and new conservation approaches and thus foster adaptive capacity of PLC.

My findings from detailed investigations of individual identity elements highlight the strong overall influence of geographical location and spatial heterogeneity on PLCA identity. Another international study which determined the influence of location to be of particular relevance to PLC was conducted by Albers et al. (2008). The authors investigated, in a spatially explicit approach for three regions in the USA, how location of statutory PAs may impact on PLC. It was found that, in California, PLCAs tended to be established in close proximity to statutory PAs whereas in Massachusetts and Illinois PLCAs contrarily appeared to be established further from statutory PAs. These findings emphasize the possibly contrary effects of close spatial proximity, where either negative influences (i.e., competition) or positive synergies (i.e. collaboration, attraction of tourists) seem to dominate. Decisions about site selection, taken by conservation agents of where to implement statutory PAs in the future, might thus influence the configuration of PLC.

7.3 How can desired PLCA Resilience be created and maintained?

Different aspects of PLCA desired resilience have been highlighted throughout my research. Components, relationships and sources of continuity have been assessed and sources of innovation have been identified and discussed. With this approach I provide a better understanding of the assets and drawbacks in PLC and of potential options for creating and maintaining PLCA identity and thus desired resilience. My research does, however, not claim to evaluate the current status quo as to how resilient individual PLCAs or PA systems are.

PLCAs and PA systems in general are embedded in changing international conditions of governance and commodification of nature (Crawhall 2015). Not only is the local context of biodiversity conservation or ecotourism relevant, but complex dynamics in nested systems across the globe influence PLCAs. Interaction of drivers and systems on different scales affect the identity of PLCAs. These impacts are caused by both slow and fast variables which are controllable to a varying extent. Many of these variables (i.e. future threats and risk concerns) are of socio-economic character (Chapter 6) which highlights the importance of a better understanding of governance and commodification contexts and related concepts such as the one of ecosystem services. For example ecotourism as a source of continuity for PLCAs is affected by social, political, economic, technological and environmental changes at all scales (Spenceley & Meyer 2012a). Factors such as population growth, redistribution of wealth, geopolitical changes and conflicts, rising fuel costs, climate change and its consequences, new technologies and work patterns, and all forms of social fashion influence who wants to travel where, for how long, to do what, and at what prices (Buckley et al. 2015).

In my research I found PLCAs to significantly differ in their corporate models (Chapter 3). These findings raise the need for a discourse around whether statutory conservation and the concept of legal 'in perpetuity' is a future solution. Diversity is important for the resilience of both ecological and social systems and is particularly relevant for networks, in which overall network resilience can be seen as a function of the summed resilience of individual nodes (Pickett & Cadenasso 1995; Norberg & Cumming 2008). Further, statutory PAs have shown to also not be as safe as expected as they are subject to downsizing and degazettement as well as issues of underfunding and lack of effectiveness (Bruner et al. 2004; Bovarnick, A. et al. 2010; Mascia & Pailler 2010; Lindsey et al. 2014). Traditional models of biodiversity conservation should be and are shifting towards more integrative models. Such models should instead (or complementarily) be focusing more on achieving dynamic conservation outcomes, fostering bottom-up approaches and enhancing decentralization and participation. This requires broad reforms (such as transaction transparency; competence, confidence and political sophistication by local institutions; granting of local discretion over environmental decision making; and downwards accountability) (Blaikie 2006).

From a critical perspective on current conservation systems addressing PLCAs, it is questionable whether real decentralisation is in progress and stumbling blocks become apparent such as lack of efficient support, focus on incorporation of properties into legal (stewardship) programmes, emphasis on legally binding agreements, lack of accurate PLCA inventories, potentially contradictory regulations or policy mismatches. For example, one study participant applied for a translocation permit for a lone male zebra (for which a holder permit existed already) within a distance of a few hundred meters onto a neighboring reserve, due to that zebra being aggressive towards visitors on site. The permit process was so delayed that the zebra eventually had to be controlled via a lethal method in order to prevent severe accidents.

Speaking in favor of integrative conservation models, one of the key principles of polycentricity is to match governance levels to the scale of the problem (Biggs et al. 2014). Functional redundancy and modularity in polycentric systems can maintain identity in the face of disturbances and change and also provide opportunities for enhanced learning and experimentation. For example, broader levels of governance can step in when lower levels collapse and fail. Further, Lebel et al. (2006) identified three specific benefits of integrative conservation where a) participation builds trust, b) multi-layered institutions improve the fit between knowledge, action, and social-ecological contexts and c) accountable authorities enhance the adaptive capacity of vulnerable groups and society as a whole.

Policymakers in various countries often address private conservation issues by offering voluntary incentive programmes, such as covenants and easements, to landowners to increase the occurrence of private species protection and biodiversity conservation (Fitzsimons & Carr 2014). Such incentives are a form of voluntary conservation strategy which are thought to have the significant advantage of increased political and social acceptability when compared to public PAs (Pasquini 2007). Further, Holmes (2013b) argues that formal incentives such as financial benefits may not be essential and that measures which incur minimal cost to government (e.g. legal recognition or laws to allow ownership of wild fauna) may have a significant impact on PLCA establishment.

Polycentric governance systems do, however, not only provide benefits and simple solutions to current conservation problems. Three main challenges occur when evaluated through the lens of ecosystem services provision and thus from the perspective of PLCAs and PA systems (Biggs et al. 2015). The first challenge is that of scale mismatches, where matching governance levels to the scales of different ecosystem services (as provided by PLCAs) may call for an impractically large number of governance arrangements. The second challenge is that of negotiating trade-offs between various ecosystem services users. Such trade-offs may occur between conflicting goals and needs among users or when impacts are incurred by those not affecting or benefiting from services. Related to this is the third challenge of resolving conflict and making collective decisions around trade-offs and around who bears the costs and who benefits from enhancing resilience.

While theory suggests that having a diversity of management strategies may be more resilient (Westley et al. 2002; Norberg et al. 2008), this diversity is unlikely to contribute to desired resilience of PLCAs if successful innovations and new knowledge are not shared. Approaches should focus on problem solving partnerships and results-driven innovation rather than being driven by institutional spending or political needs (Eberly 2008). PLCA owners and managers together with other stakeholders need to engage with people who understand the challenges they face, build diverse interactions for examples with communities, social movements economists and influencers in society and legislation (Crawhall 2015). An important approach should also be to directly assess and deal with threats and challenges such as tourism preferences, competition, local safety or invasive species.

In conclusion, both stand-alone approaches of either top-down and bottom-up conservation may not be sufficient. Berkes (2002) argues that neither top-down nor bottom-up approaches work by themselves and that there is a need for linkages across scales as well as cross-scale institutions which link systems both horizontally and vertically instead of addressing issues separately. For PLCAs in the Western Cape Province, several internal and external options exists for creating and maintaining desired resilience, as my research highlighted.

Internally, landowners and managers of PLCAs in the Western Cape Province can directly use the influence of geographic location and spatial variation in social-ecological factors to their advantage. In ecotourism for example, they could enhance the diversity of provided activities, facilities and marketed features for attraction success. This could be achieved through increased focus on specific ecological features or other characteristics that are unique to their PLCAs. Options may include promoting endemic and endangered species and habitats, or focus on other pull factors such as ancient rock art. In Sweden, Reinius & Fredman (2007) found that the legal status of PAs attracts visitors. For many PLCAs in the Western Cape Province it would be possible to attract more visitors due to accessibility (e.g. building an airstrip, improving roads) and the offered infrastructures (e.g. diversified accommodation, swimming pool, conference rooms), possibly also through enhanced marketing efforts. Visitation to PLCAs plays an important role in terms of financial viability and covering conservation costs (Lindsey et al. 2007). PLCAs could, however, also try to diversify their income sources through other activities, collaborations or funding options. Governmental programs are in place for example to support the management of invasive species through financial funding mechanisms (Department of Environmental Affairs and Tourism 2015). Other options could be to focus on the production of honey in direct collaboration between PLCA owners and managers with local beekeepers. Collaborations in general provide relevant opportunities to enhance both ecological and social resilience of PLC in the Western Cape Province. Notably, exchange of knowledge and learning could be increased through specific staff training, implementing management plans together with experts or more collaboration with research institutions. Furthermore, collaboration in close proximity with other PLCAs allows for joint action (for example management of invasive species or fire management) and even collaborating within defined conservancies. This option was not yet very common among my study participants.

From an external perspective and at a broader network scale, PLC in the Western Cape Province offers diverse options for building resilience via connectivity within and across organizational levels. Many PLCAs are not yet incorporated or engaged in governmental programs or other conservation initiatives such as CapeNature's Stewardship Programme or WWF's Biodiversity and Wine Initiative. Many study participants stated that bureaucracy was too demanding, support services are not sufficient and they fear to be too restricted in their corporate models by inappropriate regulations. Furthermore, regional conservancies and biodiversity corridors, such as the Cape West Coast Biosphere Reserve (Cape West Coast Biosphere 2015), offer opportunities to create both social and ecological resilience through for example learning and spatial connectivity. Diversity of PLC can be achieved by maintaining different management systems across the landscape (Child et al. 2013). Furthermore, more emphasis should be placed on building collaborations across scales. There is still prodigious potential for interaction between the country's national parks and provincial PAs with PLCAs. Importantly, there is a greater need for recognition and support from the government for PLC which is achievable through for example incentive programs (Langholz & Kerley 2006; Cousins et al. 2010; Selinske et al. 2015). According to Cumming et al. (2013b), an establishment of relevant institutions which act on appropriate scales as well as an increased flexibility of legislation can contribute to landscape resilience.

7.4 Identity: potential and pitfalls

In my research, I did not analyse resilience of PLC directly and do not claim to evaluate whether or not and in which way PLCAs in the Western Cape Province of South Africa are currently resilient. My approach rather highlights patterns of the *status quo* in the PLC system. It provides a better understanding of the industry and its current contexts as well as potential future opportunities and threats. Such insights help to address changes in conditions and help to strengthen adaptive capacity in order to facilitate and ensure desired resilience. Further research will need to develop suitable metrics for assessments of this desired resilience.

The identity framework as applied in my research is a very useful tool for an assessment of conservation systems. I did not methodically test the identity framework itself, but applied it to gain insight about PLC. An important advantage of the framework is that it allows to holistically think about the system. It is suitable to address single aspects, e.g. individual PLCA components, and to then relate them and understand linkages, e.g. in socio-economic interactions in PLCA networks. Results subsequently provide new perspectives on patterns and processes on different scales, e.g. the context of an individual PLCA versus clustering of PAs. Generally speaking, the framework facilitates a comprehensive identification, analysis and discussion of representative measures for each identity element (i.e. components, relationships, continuity and innovation).

A limitation, at least in the scope of my research, is the challenge of addressing PLC continuity and specifically innovation. To evaluate sources of continuity and potentials for innovation, very comprehensive assessments are needed to gain insight on several representative measures. This calls for longer-term research, e.g. in order to analyse the effectiveness of different corporate models of PLCAs over time.

7.5 Implications and Future Research

PAs play a vital role for biodiversity conservation but they face increased pressure and impact through anthropogenic factors (Folke et al. 1996; Margules & Pressey 2000). Human populations are growing and anthropogenic activities have already altered a large part of the planet (e.g. Steffen et al. 2004; Lambin & Geist 2006). This has resulted in a high rate of biodiversity loss (Sánchez-Azofeifa et al. 2002), one of the planetary boundaries (Rockström et al. 2009). Furthermore, PAs are questioned as to whether they adequately conserve biodiversity as many species and ecosystems are left underrepresented or unrepresented (Fjeldså et al. 2004; Lindsey et al. 2014). One potential solution to solving these problems is the global expansion of conservation estates (Chape et al. 2005). PLC offers a supplementary solution to expanding statutory PA networks (e.g. Langholz & Lassoie 2001; Figgis 2004).

Little, however, is known about PLCA identity and resilience and the role PLC can play in conservation systems. It is highly relevant to analyse how conservation efforts can become more efficient (Fjeldså et al. 2004), mainly with respect to private conservation action. A prime example for this need of addressing knowledge gaps is that the degree to which biodiversity is represented in PLCAs is largely unknown (Chape et al. 2005). Many countries lack accurate inventories regarding the number and extent of PLCAs (Stolton et al. 2014). Furthermore, appropriate frameworks are needed to ensure that PLC is implemented and managed sustainably (Carter et al. 2008). As for the South African context, single studies so far focused on for example local contexts, charismatic species and their role in ecotourism, contribution of PLCAs to threatened species conservation or poverty alleviation (Sims-Castley et al. 2005; Langholz & Kerley 2006; Lindsey et al. 2007; Maciejewski & Kerley 2014a). Yet, no comprehensive system analysis of PLC is available.

My study offered such a comprehensive analysis to address this knowledge gap and to better our understanding of PLCAs as SESs. I applied a comprehensive assessment approach to investigate the structure and functioning of PLCAs, to understand perturbations, and to identify opportunities for improving resilience. My investigation of PLCAs was spatially limited to the study area of the Western Cape Province. The framework is, however, applicable to studies of PLC in other regions or countries because it is not restricted to local contexts. It uses measures and indicators which can be obtained for any other situation and location. Therefore, my findings are both directly applicable to the context of the Western Cape Province as well as useful beyond provincial and national boundaries.

On the provincial and even individual level of PLCAs, my results bolster our understanding of where PLCAs are located (despite the governmental records which captured only about one third of my study participants due to their formal status and are thus not complete), what PLCAs offer and what they protect, which challenges they face, and the factors they are influenced by. This may improve management practices, collaborations or strategies.

At national and international levels, my findings correlate with study results from other regions and countries. PLCAs internationally represent similar characteristics and conditions as in the Western Cape Province when looking at for example tenure arrangements (Carter et al. 2008; Holland et al. 2014), collaborations in stakeholder networks (Vance-Borland & Holley 2011) or their role for ecotourism (Barany et al. 2001), to name but a few aspects.

PLC can contribute to creating coincident conservation and production landscapes. The range of management systems of individual PLCAs, seen on a regional scale as a network of patches, provides a potential source for experimentation and learning in ecosystem management (Child et al. 2013). Maintaining this heterogeneity can therefore be beneficial to both biodiversity and local economies. Langholz & Street (2010) also recommended combining many models of PLC ranging in size, practice, and tenure, and to ensure spatial connectivity as a potential solution for integrating economics with ecology. There is a need for dynamic PAs across the landscape in times of human disturbance and climate change (Bengtsson et al. 2003), and planning should not be based on stability (Lemieux & Scott 2005). Spatial resilience of PLC is therefore strongly linked to overall landscape sustainability which can be defined as "the capacity of a landscape to consistently provide long-term, landscape-specific ecosystem services essential for maintaining and improving human well-being" (Wu 2013).

Despite the insights gained, there is, for each element of identity and an overall better understanding of spatial resilience, scope for further research. For example, can typologies in other countries also be characterized based not solely on legal status of PAs but according to several social-ecological criteria? Comprehensive typologies would be useful for incorporating different types of PLCAs in official inventories and coordinated conservation action. As for visitation rates, their variation could not completely be explained and different variables might be needed to understand the dynamics of ecotourism to PLCAs in more detail. Another aspect of building resilience for PLCAs is the issue of property sizes (Rebelo & Siegfried 1992; Gurd et al. 2001). There is a lack of knowledge about ecologically and economically viable property sizes in relation to different factors such as maintenance costs, stocking large mammals or engaging in ecotourism. Interaction networks are also not properly understood yet. Under which conditions do sub-networks emerge? How can collaboration be strengthened across the total network in order to decrease vulnerability due to for example network fragmentation and node removal? Similarly, criteria for a successful spatial connectivity among PLCAs across the landscape are unknown. Furthermore, it is important to consider not only priority areas for conservation but to identify conservation opportunity and therefore assess the willingness of landowners and other actors to engage, participate and collaborate in conservation.

In summary, my study illuminates the inherently social-ecological character of PLC. Socio-economic and ecological components are strongly interlinked and influence the functioning of individual PAs as well as entire conservation systems. Notably, PLCA identity and resilience are substantially influenced by diverse spatial factors. These spatial factors together with other pattern-process interactions across scales have to be incorporated in implementation and management of PLC. There are numerous opportunities to do so in order to ensure and enhance PLC resilience, which is highly relevant for securing provision of both ecological and socio-economic benefits to society.

References

Abdi, H., and L. J. Williams. 2010. Principal component analysis. Wiley Interdisciplinary Reviews: Computational Statistics **2**:433–459.

ABSA. 2003. Game Ranch Profitability in Southern Africa. Absa:73.

Adams, V. M., and K. Moon. 2013. Security and equity of conservation covenants: Contradictions of private protected area policies in Australia. Land Use Policy **30**:114–119. Elsevier Ltd. Available from http://dx.doi.org/10.1016/j.landusepol.2012.03.009.

Adams, W. M. 2004. Against extinction: the story of conservation. Earthscan, London.

Agrawal, A. 2003. Sustainable governance of common-pool resources: Context, Methods, and Politics. Annual Review of Anthropology **32**:243–262.

Akaike, H. 1974. A new look at the statistical model identification. IEEE Transactions on Automatic Control **19**:716–723.

Akinboade, O., and L. Braimoh. 2010. International tourism and economic development in South Africa: A Granger causality test. International Journal of Tourism … **163**:149–163.

Albers, H. J., A. W. Ando, and X. Chen. 2008. Spatial-econometric analysis of attraction and repulsion of private conservation by public reserves. Journal of Environmental Economics and Management **56**:33–49.

Alpízar, F. 2006. The pricing of protected areas in nature-based tourism: A local perspective. Ecological Economics **56**:294–307. Available from http://linkinghub.elsevier.com/retrieve/pii/S0921800905001023.

Amaral, L. A., A. Scala, M. Barthelemy, and H. E. Stanley. 2000. Classes of small-world networks. Proceedings of the National Academy of Sciences of the United States of America **97**:11149–11152.

Ament, J. M., C. A. Moore, M. Herbst, and G. S. Cumming. 2016. Cultural ecosystem services in protected areas: understanding bundles, trade-offs and synergies. Under review.

Anderies, J. M., C. Folke, B. Walker, and E. Ostrom. 2013. Aligning Key Concepts for Global Change Policy: Robustness, Resilience, and Sustainability. Ecology and Society **18**. Available from http://www.ecologyandsociety.org/vol18/iss2/art8/.

Anderies, J. M., M. A. Janssen, and E. Ostrom. 2004. A framework to analyze the robustness of social-ecological systems from an institutional perspective. Ecology and society **9**:18. Available from http://www.ecologyandsociety.org/vol9/iss1/art18/\nhttp://www.ecologyandsociety.org/vol9/iss1/art18.

Anderson, H. J. 2003. An economic analysis of the wildlife market in South Africa. University of Cape Town.

Archer, E. R. M. 2004. Beyond the “climate versus grazing” impasse: Using remote sensing to investigate the effects of grazing system choice on vegetation cover in the eastern Karoo. Journal of Arid Environments **57**:381–408.

Barabási, A.-L. 2009. Scale-free networks: a decade and beyond. Science **325**:412–413.

Barany, M. E., A. L. Hammett, L. J. Shillington, and B. R. Murphy. 2001. The Role of Private Wildlife Reserves in Nicaragua’s Emerging Ecotourism Industry. Journal of Sustainable Tourism **9**:95–110.

Barnard, P., C. J. Brown, A. M. Jarvis, A. Robertson, and L. Van Rooyen. 1998. Extending the Namibian protected area network to safeguard hotspots of endemism and diversity. Biodiversity and

Conservation **7**:531–547.

Barnes, J. . 1998. Wildlife conservation and utilisation as complements to agriculture in southern African development. DEA Research Discussion Paper:20.

Barthel, S., C. Folke, and J. Colding. 2010. Social–ecological memory in urban gardens—Retaining the capacity for management of ecosystem services. Global Environmental Change **20**:255–265. Available from http://linkinghub.elsevier.com/retrieve/pii/S0959378010000026.

Bascompte, J. 2007. Networks in ecology. Basic and Applied Ecology **8**:485–490.

Bastian, M., S. Heymann, and M. Jacomy. 2009. Gephi: an open source software for exploring and manipulating networks. International AAAI Conference on Weblogs and Social Media. Available from http://gephi.github.io/.

Bates, D., M. Mächler, B. Bolker, S. Walker, R. Christensen, H. Singmann, and B. Dai. 2015. Package "lme4." Available from http://cran.r-project.org/web/packages/lme4/lme4.pdf.

Beinert, W. 2003. The rise of conservation in South Africa. Oxford Univeristy Press.

Bengtsson, J., P. Angelstam, T. Elmqvist, U. Emanuelsson, C. Folke, M. Ihse, F. Moberg, and M. Nyström. 2003. Reserves, resilience and dynamic landscapes. Ambio **32**:389–396.

Bennett, E. M., G. D. Peterson, and L. J. Gordon. 2009. Understanding relationships among multiple ecosystem services. Ecology Letters **12**:1394.

Bergsten, A., and A. Zetterberg. 2013. To model the landscape as a network: A practitioner's perspective. Landscape and Urban Planning **119**:35–43. Elsevier B.V. Available from http://dx.doi.org/10.1016/j.landurbplan.2013.06.009.

Berkes, F. 2002. Cross-scale institutional linkages: Perspectives from the bottom-up. in E. Ostrom, T. Dietz, N. Dolšak, P. C. Stern, S. Stovich, and E. U. Weber, editors. The Drama of the Commons. National Academy Press, Washington.

Berkes, F., and N. J. Turner. 2006. Knowledge, Learning and the Evolution of Conservation Practice for Social-Ecological System Resilience. Human Ecology **34**:479–494. Available from http://link.springer.com/10.1007/s10745-006-9008-2.

BGIS. 2015. Biodiversity GIS. Available from http://bgis.sanbi.org/ (accessed March 1, 2015).

Biggs, D., L. Swemmer, G. Phillips, J. Stevens, S. Freitag, and R. Grant. 2014. The development of a tourism research framework by South African National Parks to inform management. Koedoe **56**:1–9. Available from http://www.koedoe.co.za/index.php/koedoe/article/view/1164.

Biggs, R. et al. 2012. Toward Principles for Enhancing the Resilience of Ecosystem Services. Annual Review of Environment and Resources **37**:421–448.

Biggs, R., M. Schlüter, and M. L. Schoon. 2015. Principles for Building Resilience: Sustaining Ecosystem Services in Social-Ecological Systems. Cambridge University Press.

Binns, T., and E. Nel. 2002. Tourism as a local development strategy in South Africa. The Geographic Journal **168**:235–247.

Blaikie, P. 2006. Is Small Really Beautiful? Community-based Natural Resource Management in Malawi and Botswana. World Development **34**:1942–1957.

Boccaletti, S., V. Latora, Y. Moreno, M. Chavez, and D. U. Hwang. 2006. Complex networks: Structure and dynamics. Physics Reports **424**:175–308.

Bodin, Ö., and B. I. Crona. 2009. The role of social networks in natural resource governance: What relational patterns make a difference? Global Environmental Change **19**:366–374.

Bond, I., B. Child, D. de la Harpe, B. Jones, J. Barnes, and H. J. Anderson. 2004. Private Land Contribution to Conservation in South Africa. Pages 29–62 in B. Child, editor. Parks in Transition: Biodiversity, Rural Development, and the Bottom Line. Earthscan, London.

Borcard, D., P. Legendre, and P. Drapeau. 1992. Partialling out the Spatial Component of Ecological Variation. Ecology **73**:1045–1055.

Boshoff, A. F., G. I. H. Kerley, and R. M. Cowling. 2002. Estimated spatial requirements of the medium- to large-sized mammals, according to broad habitat units, in the Cape Floristic Region, South Africa. African Journal of Range & Forage Science **19**:29–44.

Bothma, J. du P., H. Suich, and A. Spenceley. 2009. Extensive wildlife production on private land in South Africa. Pages 163–184 in H. Suich, B. Child, and A. Spenceley, editors. Evolution and innovation in wildlife conservation - parks and game ranches to transfrontier conservation areas. Earthscan, London.

Bovarnick, A., J., F. Baca, J. Galindo, and H. Negret. 2010. Financial Sustainability of Protected Areas in Latin America and the Caribbean: Investment Policy Guidance. UNDP and TNC.

Brooks, S., M. Spierenburg, L. Van Brakel, A. Kolk, and K. B. Lukhozi. 2011. Creating a commodified wilderness: Tourism, private game farming, and "third nature" landscapes in KwaZulu-Natal. Tijdschrift voor Economische en Sociale Geografie **102**:260–274.

Brooks, T. M. et al. 2004. Coverage Provided by the Global Protected-Area System: Is It Enough? BioScience **54**:1081.

Bruner, A. G., R. E. Gullison, and A. Balmford. 2004. Financial Costs and Shortfalls of Managing and Expanding Protected-Area Systems in Developing Countries. BioScience **54**:1119.

Buckley, R. 2003. Environmental Inputs and Outputs in Ecotourism: Geotourism with a Positive Triple Bottom Line? Journal of Ecotourism **2**:76–82.

Buckley, R. 2009. Parks and Tourism. PLoS Biology **7**:e1000143. Available from http://dx.plos.org/10.1371/journal.pbio.1000143.

Buckley, R., U. Gretzel, D. Scott, D. Weaver, and S. Becken. 2015. Tourism megatrends. Tourism Recreation Research **40**:59–70. Available from http://www.tandfonline.com/doi/full/10.1080/02508281.2015.1005942.

Calhoun, A. J. K., J. S. Jansujwicz, K. P. Bell, and M. L. Hunter. 2014. Improving management of small natural features on private lands by negotiating the science-policy boundary for Maine vernal pools. Proceedings of the National Academy of Sciences of the United States of America **111**:1–5. Available from http://www.ncbi.nlm.nih.gov/pubmed/25002496.

Cape Nature. 2015. Care for Nature: stewardship. Available from http://www.capenature.co.za/care-for-nature/stewardship/ (accessed February 15, 2015).

Cape West Coast Biosphere. 2015. Cape West Coast Biosphere. Available from http://www.capebiosphere.co.za/ (accessed February 20, 2015).

Carpenter, S. R. et al. 2009. Science for managing ecosystem services: Beyond the Millennium Ecosystem Assessment. Proceedings of the National Academy of Sciences of the United States of America **106**:1305–1312.

Carruthers, J. 2008. "Wilding the farm or farming the wild"? The evolution of scientific game ranching in South Africa from the 1960s to the present. Transactions of the Royal Society of South Africa **63**:160–181.

Carter, E., W. M. Adams, and J. Hutton. 2008. Private protected areas: management regimes, tenure arrangements and protected area categorization in East Africa. Oryx **42**:177–186.

CBD Secretariat. 2015a. Convention on Biological Diversity. Article 2. Use of Terms. Available from http://www.cbd.int/convention/articles/default.shtml?a=cbd-02 (accessed February 23, 2015).

CBD Secretariat. 2015b. Aichi Target 11. Available from http://www.cbd.int/sp/targets/rationale/target-11/default.shtml (accessed February 3, 2015).

Chan, J. K. L., and T. Baum. 2007. Ecotourists' perception of ecotourism experience in lower Kinabatangan, Sabah, Malaysia. Journal of Sustainable Tourism **15 (5)**:574–590. Available from http://dx.doi.org/10.2167/jost679.0.

Chape, S., J. Harrison, M. Spalding, and I. Lysenko. 2005. Measuring the extent and effectiveness of protected areas as an indicator for meeting global biodiversity targets. Philosophical transactions of the Royal Society of London. Series B, Biological sciences **360**:443–455.

Chase, L. C., D. R. Lee, W. D. Schulze, and D. J. Anderson. 1998. Ecotourism Demand and Differential Pricing of National Park Access in Costa Rica. Land Economics **74**:466–482.

Chief Surveyor General. 2016. Cadastral Data. Available from http://csg.dla.gov.za/spatial.htm (accessed February 7, 2016).

Child, B. A., J. Musengezi, G. D. Parent, and G. F. T. Child. 2012. The economics and institutional economics of wildlife on private land in Africa. Pastoralism: Research, Policy and Practice **2**.

Child, M. F., M. J. S. Peel, I. P. J. Smit, and W. J. Sutherland. 2013. Quantifying the effects of diverse private protected area management systems on ecosystem properties in a savannah biome, South Africa. Oryx **47**:29–40. Available from http://www.journals.cambridge.org/abstract_S0030605312000038.

Clements, H., G. S. Cumming, and J. Baum. 2016. Money and motives: An organizational ecology perspective on private land conservation. Biological Conservation **in press**.

Collier, J. 2010. A dynamical approach to identity and diversity in complex systems. Complexity, Difference and Identity:83–97. Available from http://link.springer.com/chapter/10.1007/978-90-481-9187-1_5.

Conservation at Work. 2015. Conservation at Work. Available from http://www.conservationatwork.co.za/ (accessed January 17, 2015).

Cooke, B., W. T. Langford, A. Gordon, and S. Bekessy. 2012. Social context and the role of collaborative policy making for private land conservation. Journal of Environmental Planning and Management **55**:469–485.

Costanza, R., R. de Groot, P. Sutton, S. van der Ploeg, S. J. Anderson, I. Kubiszewski, S. Farber, and R. K. Turner. 2014. Changes in the global value of ecosystem services. Global Environmental Change **26**:152–158. Elsevier Ltd. Available from http://dx.doi.org/10.1016/j.gloenvcha.2014.04.002.

Cousins, J. A., J. P. Sadler, and J. Evans. 2008. Exploring the role of private wildlife ranching as a conservation tool in South Africa: Stakeholder perspectives. Ecology and Society **13**:43.

Cousins, J. A., J. P. Sadler, and J. Evans. 2010. The challenge of regulating private wildlife ranches for conservation in South Africa. Ecology and Society **15**:23.

Cowling, R. M. J., R. L. Pressey, A. T. Lombard, P. G. Desmet, and A. G. Ellis. 1999. From representation to persistence : for a requirements of conservation sustainable system areas in the species- rich mediterranean-climate desert of southern Africa. Diversity and Distributions **5**:50–71.

Crane, W. 2006. Biodiversity conservation and land rights in South Africa: Whither the farm dwellers? Geoforum **37**:1035–1045. Available from http://www.sciencedirect.com/science/article/pii/S0016718506000972.

Crawhall, N. 2015. Social and economic influences shaping protected areas. Pages 117–144 in G. L. Worboys, M. Lockwood, A. Kothari, S. Feary, and I. Pulsford, editors. Protected Area Governance and Management. ANU Press, Canberra.

Cumming, D. H. M. 1991. Wildlife products and the market place: a view from Southern Africa. Pages 11–25 in L. A. Renecker and R. J. Hudson, editors. Wildlife Production: Conservation and Sustainable DevelopmentAFES misc. University of Alaska Fairbanks.

Cumming, D. H. M. 2004. Performance of parks in a century of change. Pages 105–124 in B. Child, editor. Parks in Transition: Biodiversity, Rural Development, and the Bottom Line. Earthscan, London.

Cumming, D. H. M., S. A. Osofsky, S. J. Atkinson, and M. W. Atkinson. 2015a. Beyond Fences : Wildlife , Livestock and Land Use in Southern Africa. Pages 243–257 in J. Zinsstag, editor. One health: The theory and practice of integrated health approaches.

Cumming, G., A. Buerkert, E. Hoffmann, E. Schlecht, S. von Cramon-Taubadel, and T. Tscharntke. 2014. Implications of agricultural transitions and urbanization for ecosystem services. Nature **515**:50–57.

Cumming, G. S. 2011. Spatial resilience in social-ecological systems. Springer.

Cumming, G. S. et al. 2015b. Understanding protected area resilience: a multi-scale, social-ecological approach. Ecological Applications **25**:299 – 319.

Cumming, G. S., G. Barnes, S. Perz, M. Schmink, K. E. Sieving, J. Southworth, M. Binford, R. D. Holt, C. Stickler, and T. Van Holt. 2005. An exploratory framework for the empirical measurement of resilience. Ecosystems **8**:975–987.

Cumming, G. S., Ö. Bodin, H. Ernstson, and T. Elmqvist. 2010. Network analysis in conservation biogeography: Challenges and opportunities. Diversity and Distributions **16**:414–425.

Cumming, G. S., and J. Collier. 2005. Change and identity in complex systems. Ecology and Society **10**:29.

Cumming, G. S., P. Olsson, F. S. Chapin, and C. S. Holling. 2013. Resilience, experimentation, and scale mismatches in social-ecological landscapes. Landscape Ecology **28**:1139–1150.

Cumming, T., and F. Daniels. 2014. South Africa. Pages 88 – 91 in S. Stolton, K. H. Redford, and N. Dudley, editors. The Futures of Privately Protected Areas. IUCN.

D’Amico, H. J., S. A. Osofsky, and D. H. M. Cumming. 2004. Wildlife health in Africa: implications for conservation in the decades ahead. Pages 129–130 in N. Burgess, H. J. D’Amico, E. Underwood, E. Dinerstein, D. Olson, I. Itoua, J. Schipper, T. Ricketts, and K. Newman, editors. The Terrestrial Ecoregions of Africa and Madagascar: A Conservation Assessment. Island Press, Washington.

Daily, G. C. 1997. What are ecosystem services? in G. C. Daily, editor. Nature’s Services: societal dependence on natural ecosystems. Island Press.

Daniel, T. C. et al. 2012. Contributions of cultural services to the ecosystem services agenda. Proceedings of the National Academy of Sciences **109**:8812–8819.

De Alessi, M. 2000. Private Conservation and Black Rhinos in Zimbabwe: The Savé Valley and Bubiana Conservancies. Center for Private Conservation, Competitive Enterprise Institute, Washington, DC. Available from http://dlc.dlib.indiana.edu/dlc/handle/10535/5863.

De Klerk, H. M., J. Fjeldså, S. Blyth, and N. D. Burgess. 2004. Gaps in the protected area network for threatened Afrotropical birds. Biological Conservation **117**:529–537.

de la Harpe, D. 2004. Does “commercialization” of protected areas threaten their conservation goals? Pages 190–216 in B. Child, editor. Parks in Transition: Biodiversity, Rural Development, and the Bottom Line. Earthscan.

De Vasconcellos Pegas, F., and J. G. Castley. 2014. Ecotourism as a conservation tool and its adoption by private protected areas in Brazil. Journal of Sustainable Tourism **22**:604–625. Available from http://www.tandfonline.com/doi/abs/10.1080/09669582.2013.875550.

De Vos, A. 2014. Private Protected Areas in South Africa. Unpublished Spatial Dataset.

De Vos, A., G. S. Cumming, D. Cumming, C. Moore, J. M. Ament, J. Baum, H. Clements, J. Grewar, and K. Maciejewski. 2016a. Pathogens, disease, and the social-ecological resilience of protected areas. Ecology and Society **21**.

De Vos, A., G. S. Cumming, C. A. Moore, and K. Maciejewski. 2016b. Understanding constraints on ecotourism in protected areas: the implications of location for economic sustainability. Ecosphere **in press**.

Department of Environmental Affairs and Tourism. 2005. South Africa’s National Biodiversity Strategy and Action Plan. Available from https://www.environment.gov.za/sites/default/files/docs/nationalbiodiversit_stractandactionplan.pdf (accessed March 7, 2015).

Department of Environmental Affairs and Tourism. 2014. Strategic Plan 2014 - 2019. Available from https://www.environment.gov.za/documents/reports (accessed March 7, 2015).

Department of Environmental Affairs and Tourism. 2015. Working for Water. Available from https://www.environment.gov.za/projectsprogrammes/wfw (accessed January 17, 2015).

Department of Rural Development and Land Reform. 2013. Land Audit as approved by Cabinet September 5 2013. Pretoria.

Di Minin, E., I. Fraser, R. Slotow, and D. C. Macmillan. 2013. Understanding heterogeneous preference of tourists for big game species: Implications for conservation and management. Animal Conservation **16**:249–258.

Doan, T. M. 2000. The Effects of Ecotourism in Developing Nations: An Analysis of Case Studies. Journal of Sustainable Tourism **8**:288–304.

Dramstad, W. E., M. S. Tveit, W. J. Fjellstad, and G. L. A. Fry. 2006. Relationships between visual landscape preferences and map-based indicators of landscape structure. Landscape and Urban Planning **78**:465–474.

Eberly, D. E. 2008. The rise of global civil society: building communities and nations from the bottom-up. Encounter Books, New York.

Ehrlich, P. R., and H. A. Mooney. 1983. Extinction , Substitution , and Ecosystem Services. BioScience **33**:248–254.

Ellingson, L., and A. Seidl. 2007. Comparative analysis of non-market valuation techniques for the Eduardo Avaroa Reserve, Bolivia. Ecological Economics **60**:517–525. Available from http://linkinghub.elsevier.com/retrieve/pii/S0921800906003545.

Erb, K. P. 2004. Consumptive wildlife utilization as a land-use form in Namibia. University of Stellenbosch. Available from http://hdl.handle.net/10019.1/49892.

Ervin, J. 2003. Protected area assessments in perspective. BioScience **53**:819–822.

Figgis, P. 2004. Conservation on private land: The Australian experience. Gland, Switzerland.

Fisher, J. R. B., and B. Dills. 2012. Do Private Conservation Activities Match Science-Based

Conservation Priorities? PLoS ONE **7**:1 – 7.

Fitzsimons, J. A., and C. Ben Carr. 2014. Conservation covenants on private land: Issues with measuring and achieving biodiversity outcomes in Australia. Environmental Management **54**:606–616.

Fitzsimons, J. a., and G. Wescott. 2001. The role and contribution of private land in Victoria to biodiversity conservation and the protected area system. Australian Journal of Environmental Management **8**:142–157.

Fitzsimons, J. A., and G. Wescott. 2004. The classification of lands managed for conservation: Existing and proposed frameworks, with particular reference to Australia. Environmental Science and Policy **7**:477–486.

Fitzsimons, J. A., and G. Wescott. 2005. History and Attributes of Selected Australian Multi-tenure Reserve Networks. Australian Geographer **36**:75–93.

Fitzsimons, J. a., and G. Wescott. 2008a. The role of multi-tenure reserve networks in improving reserve design and connectivity. Landscape and Urban Planning **85**:163–173.

Fitzsimons, J. a., and G. Wescott. 2008b. Ecosystem conservation in multi-tenure reserve networks: The contribution of land outside of publicly protected areas. Pacific Conservation Biology **14**:250–262.

Fjeldså, J., N. D. Burgess, S. Blyth, and H. M. De Klerk. 2004. Where are the major gaps in the reserve network for Africa's mammals? Oryx **38**:17 – 25.

Folke, C. et al. 2011. Reconnecting to the Biosphere. Ambio **40**:719–738. Available from http://link.springer.com/10.1007/s13280-011-0184-y.

Folke, C., S. Carpenter, T. Elmqvist, L. Gunderson, C. S. Holling, and B. Walker. 2002. Resilience and sustainable development: building adaptive capacity in a world of transformations. Ambio **31**:437–440. Available from http://www.jstor.org/stable/4315276.

Folke, C., S. R. Carpenter, B. H. Walker, M. Scheffer, F. S. Chapin, and J. Rockström. 2010. Resilience thinking: integrating resilience, adaptability and transformability. Ecology and Society **15**.

Folke, C., S. Carpenter, B. Walker, M. Scheffer, T. Elmqvist, L. Gunderson, and C. S. Holling. 2004. Regime Shifts , Resilience , and Biodiversity in Ecosystem Management. Annual Review of Ecology, Evolution, and Systematics **35**:557–581.

Folke, C., C. S. Holling, and C. Perrings. 1996. Biological diversity, ecosystems, and the human scale 383. Ecological Applications **6**:1018–1024.

Frazee, S. R., R. M. Cowling, R. L. Pressey, J. K. Turpie, and N. Lindenberg. 2003. Estimating the costs of conserving a biodiversity hotspot: A case-study of the Cape Floristic Region, South Africa. Biological Conservation **112**:275–290.

Frith, A. 2010. Map of South Africa with provincial borders. Available from http://commons.wikimedia.org/wiki/File:Map_of_South_Africa_with_provincial_borders.svg (accessed March 4, 2015).

Gallo, J. A., L. Pasquini, B. Reyers, and R. M. Cowling. 2009. The role of private conservation areas in biodiversity representation and target achievement within the Little Karoo region, South Africa. Biological Conservation **142**:446–454. Available from http://dx.doi.org/10.1016/j.biocon.2008.10.025.

Geldmann, J., M. Barnes, L. Coad, I. D. Craigie, M. Hockings, and N. D. Burgess. 2013. Effectiveness of terrestrial protected areas in reducing habitat loss and population declines. Biological Conservation **161**:230–238. Elsevier Ltd. Available from http://linkinghub.elsevier.com/retrieve/pii/S0006320713000670.

González, J. a, C. Montes, J. Rodríguez, and W. Tapia. 2008. Rethinking the Galápagos Islands as a Complex Social-Ecological System: Implications for Conservation and Management. Ecology and Society **13**:13. Available from http://www.ecologyandsociety.org/vol13/iss2/art13/.

Goodman, P. S., B. James, and L. Carlisle. 2002. Wildlife utilisation: Its role in fostering biodiversity conservation in KwaZulu-Natal. Pages 21–31 in S. M. Pierce, R. M. Cowling, T. Sandwith, and K. MacKinnon, editors. Mainstreaming Biodiversity i Development. World Bank Environment Department, Washington.

Goss, J. R., and G. S. Cumming. 2013. Networks of wildlife translocations in developing countries: An emerging conservation issue? Frontiers in Ecology and the Environment **11**:243–250.

Government of South Africa. 2004. National Environmental Management: Protected Areas Act, 2003. Government Gazette **464**.

Government of South Africa. 2010. National Protected Area Expansion Strategy for South Africa 2008. Pretoria. Available from https://www.environment.gov.za/sites/default/files/docs/nationalprotected_areasexpansion_strategy.pdf (accessed March 7, 2015).

Grantham, H. S., M. Bode, E. McDonald-Madden, E. T. Game, A. T. Knight, and H. P. Possingham. 2010. Effective conservation planning requires learning and adaptation. Frontiers in Ecology and the Environment **8**:431–437.

Green, L. 2010. A landscape with objects: private game reserves, game lodges and the “New Safari.” Social Dynamics **36**:288–301.

Guerrero, A. M., R. R. J. McAllister, J. Corcoran, and K. A. Wilson. 2013. Scale Mismatches, Conservation Planning, and the Value of Social-Network Analyses. Conservation Biology **27**:35–44.

Guerry, A. D. et al. 2015. Natural capital and ecosystem services informing decisions: From promise to practice. Proceedings of the National Academy of Sciences **112**:201503751. Available from http://www.pnas.org/lookup/doi/10.1073/pnas.1503751112.

Gunderson, L. H. 2000. Ecological resilience - in theory and application. Annual Review of Ecological Systems **31**:425 – 439.

Gurd, D. B., T. D. Nudds, and D. H. Rivard. 2001. Conservation of mammals in eastern North American wildlife reserves: How small is too small? Conservation Biology **15**:1355–1363.

Haines-Young, R., and M. Potschin. 2013. Common International Classification of Ecosystem Services (CICES): Consultation on Version 4, August-December 2012. EEA Framework Contract No **EEA/IEA/09**. Available from www.cices.eu.

Hartigan, J. A. 1975. Clustering Algorithms. Wiley, New York.

Hayward, M. W. et al. 2007. The reintroduction of large carnivores to the Eastern Cape, South Africa: an assessment. Oryx **41**:205.

Hearne, R. R., and Z. M. Salinas. 2002. The use of choice experiments in the analysis of tourist preferences for ecotourism development in Costa Rica. Journal of Environmental Management **65**:153–163.

Hernández-Morcillo, M., T. Plieninger, and C. Bieling. 2013. An empirical review of cultural ecosystem service indicators. Ecological Indicators **29**:434–444. Elsevier Ltd. Available from http://dx.doi.org/10.1016/j.ecolind.2013.01.013.

Holland, M. B., F. de Koning, M. Morales, L. Naughton-Treves, B. E. Robinson, and L. Suárez. 2014. Complex Tenure and Deforestation: Implications for Conservation Incentives in the Ecuadorian Amazon. World Development **55**:21–36.

Holling, C. S. 1973. Resilience and Stability of Ecological Systems. Annual Review of Ecology and Systematics **4**:1–23.

Holling, C. S. 2001. Understanding the complexity of economic, ecological, and social systems. Ecosystems **4**:390 – 405.

Holmes, G. 2013a. What role do private protected areas have in conserving global biodiversity? Sustainability Research Institute (SRI):1–26.

Holmes, G. 2013b. Exploring the relationship between local support and the success of protected areas. Conservation and Society **11**:72–82. Available from http://www.academia.edu/3352791/Exploring_the_Relationship_Between_Local_Support_and_the_Success_of_Protected_Areas\nwww.conservationandsociety.org.

Hutton, J., W. M. Adams, and J. C. Murombedzi. 2005. Back to the Barriers? Changing Narratives in Biodiversity Conservation. Forum for Development Studies **32**:341–370.

Iftekhar, M. S., J. G. Tisdell, and L. Gilfedder. 2014. Private lands for biodiversity conservation: Review of conservation covenanting programs in Tasmania, Australia. Biological Conservation **169**:176–184. Elsevier Ltd. Available from http://dx.doi.org/10.1016/j.biocon.2013.10.013.

Igraph Core Development Team. 2015. Igraph - The network analysis package. Available from http://igraph.org/redirect.html (accessed March 4, 2015).

Indalo. 2016. Private Game Reserves - Eastern Cape. Available from http://indaloconservation.co.za/ (accessed January 26, 2016).

Infield, M. 2001. Cultural Values : a forgotten strategy for building community support for protected areas in Africa. Conservation Biology **15**:800–802.

IUCN. 2005. Private Protected Areas. Parks **15**.

Jamal, T., and A. Stronza. 2009. Collaboration theory and tourism practice in protected areas: stakeholders, structuring and sustainability. Journal of Sustainable Tourism **17**:169–189.

James, D. 2000. “After years in the wilderness”: The discourse of land claims in the New South Africa. Journal of Peasant Studies **27**:142–161.

Janssen, M. A., O. Bodin, J. M. Anderies, T. Elmqvist, H. Ernstson, R. R. J. McAllister, P. Olson, and P. Ryan. 2006. Toward a Network Perspective of the Study of Resilience in Social-Ecological Systems. Ecology and Society **11**:15. Available from http://www.ecologyandsociety.org/vol11/iss1/art15/.

Johnson, J. B., and K. S. Omland. 2004. Model selection in ecology and evolution. Trends in Ecology and Evolution **19**:101–108.

Jones, B. T. B., S. Stolton, and N. Dudley. 2005. Private protected areas in East and southern Africa: contributing to biodiversity conservation and rural development. Parks **15**:67 – 77.

Joppa, L. N., and A. Pfaff. 2009. High and far: Biases in the location of protected areas. PLoS ONE **4**:1–6.

Kamal, S., and M. Grodzinska-Jurczak. 2014. Should conservation of biodiversity involve private land? A Q methodological study in Poland to assess stakeholders’ attitude. Biodiversity and Conservation **23**:2689–2704. Available from http://link.springer.com/10.1007/s10531-014-0744-0.

Kamal, S., M. Kocór, and M. Grodzinska-Jurczak. 2015. Conservation opportunity in biodiversity conservation on regulated private lands: Factors influencing landowners' attitude. Environmental Science and Policy **54**:287–296.

Kepe, T. 2008. Land claims and comanagement of protected areas in South Africa: Exploring the challenges. Environmental Management **41**:311–321.

Kepe, T., M. Saruchera, and W. Whande. 2004. Poverty alleviation and biodiversity conservation: a South African perspective. Oryx **38**:143–145.

Kepe, T., R. Wynberg, and W. Ellis. 2005. Land reform and biodiversity conservation in South Africa: complementary or in conflict? International Journal of Biodiversity Science, Ecosystems Services & Management **1**:3–16.

Kettunen, M., and P. ten Brink. 2013. The Social and Economic Benefits of Protected Areas: An Assessment Guide. Routledge.

Keys, N., M. Bussey, D. C. Thomsen, T. Lynam, and T. F. Smith. 2014. Building adaptive capacity in South East Queensland, Australia. Regional Environmental Change **14**:501–512.

Khan, H. 2004. Demand for eco-tourism: estimating recreational benefits from the margalla hills national park in northern Pakistan. Available from http://www.sandeeonline.org/uploads/documents/publication/779_PUB_himy_final.pdf.

Kim, S. S., L. Choong-Li, and D. B. Klenosky. 2003. The influence of push and pull factors at Korean national parks. Tourism Management **24**:169–180.

Kinzig, A. P., P. Ryan, M. Etienne, H. Allison, T. Elmqvist, and B. H. Walker. 2006. Resilience and regime shifts: Assessing cascading effects. Ecology and Society **11**.

Kirkwood, D., G. Q. Pence, and A. von Hase. 2010. Western Cape Biodiversity Framework: Critical Biodiversity Areas and Ecological Support Areas of the Western Cape. A C.A.P.E. Land-use planning project. Unpublished Project Report. Available from http://bgis.sanbi.org/WCBF14/project.asp.

Knight, A. T., R. M. Cowling, M. Difford, and B. M. Campbell. 2010. Mapping human and social dimensions of conservation opportunity for the scheduling of conservation action on private land. Conservation Biology **24**:1348–1358.

Knight, A. T., H. S. Grantham, R. J. Smith, G. K. McGregor, H. P. Possingham, and R. M. Cowling. 2011. Land managers' willingness-to-sell defines conservation opportunity for protected area expansion. Biological Conservation **144**:2623–2630. Available from http://dx.doi.org/10.1016/j.biocon.2011.07.013.

Knoot, T. G., L. A. Schulte, and M. Rickenbach. 2010. Oak conservation and restoration on private forestlands: Negotiating a social-ecological landscape. Environmental Management **45**:155–164.

Kreuter, U., M. Peel, and E. Warner. 2010. Wildlife Conservation and Community-Based Natural Resource Management in Southern Africa's Private Nature Reserves. Society & Natural Resources: An International Journal **23**:507–524. Available from http://www.informaworld.com/10.1080/08941920903204299.

Krug, W. 2001. Private supply of protected land in southern Africa: a review of markets, approaches, barriers and issues. Pages 1–42 World Bank / OECD International Workshop on Market Creation for Biodiversity Products and Services. Available from http://eprints.ucl.ac.uk/17613/.

Lai, P.-H., and S. Shafer. 2005. Marketing Ecotourism through the Internet: An Evaluation of Selected Ecolodges in Latin America and the Caribbean. Journal of Ecotourism **4**:143–160.

Laita, A., M. Mönkkönen, and J. S. Kotiaho. 2010. Woodland key habitats evaluated as part of a functional reserve network. Biological Conservation **143**:1212–1227. Elsevier Ltd. Available from http://dx.doi.org/10.1016/j.biocon.2010.02.029.

Lambin, E. F., and H. Geist. 2006. Land-use and land-cover change: local processes and global impacts. Springer.

Langholz, J. 1996. Economics, objectives, and success of private nature reserves in Sub-Saharan Africa and Latin America. Conservation Biology **10**:271–280. Available from http://www.blackwell-synergy.com/links/doi/10.1046/j.1523-1739.1996.10010271.x/abs.

Langholz, J. 2010. Global Trends in Private Protected Areas and Their Implications for the Northern Great Plains. Great Plains Research **20 (1)**:1–9.

Langholz, J. A., and G. I. H. Kerley. 2006. Combining conservation and development on private lands: an assessment of ecotourism-based private game reserves in the Eastern Cape. Centre for African Conservation Ecology (formerly TERU) Report:1–34.

Langholz, J. A., and W. Krug. 2004. New Forms of Biodiversity Governance: Non-State Actors and the Private Protected Area Action Plan. Journal of International Wildlife Law & Policy **7**:9–29.

Langholz, J. A., and J. P. Lassoie. 2001. Perils and Promise of Privately Owned Protected Areas. BioScience **51**:1079.

Langholz, J., J. Lassoie, and J. Schelhas. 2000. Incentives for Private Conservation : Wildlife Refuge Program. Conservation Biology **14**:1735–1743.

Lauber, T. B., R. C. Stedman, D. J. Decker, B. a. Knuth, and C. N. Simon. 2011. Social Network Dynamics in Collaborative Conservation. Human Dimensions of Wildlife **16**:259–272.

Laurance, W. F. et al. 2012. Averting biodiversity collapse in tropical forest protected areas. Nature **489**:290–294. Nature Publishing Group. Available from http://dx.doi.org/10.1038/nature11318.

Lebel, L., J. M. Anderies, B. Campbell, C. Folke, S. Hatfield-Dodds, T. P. Hughes, and J. Wilson. 2006. Governance and the Capacity to Manage Resilience in Regional Social-Ecological Systems. Ecology and Society **1**.

Legendre, P., and L. Legendre. 2012. Numerical Ecology, 3rd edition. Elsevier.

Lemieux, C. J., and D. J. Scott. 2005. Climate change, biodiversity conservation and protected area planning in Canada. Canadian Geographer **49**:384–397. Available from http://www.blackwell-synergy.com/doi/abs/10.1111/j.0008-3658.2005.00103.x\nhttp://www.ingentaconnect.com/content/bpl/cag/2005/00000049/00000004/art00005\nWOS:000234474600005.

Leverington, F., K. L. Costa, H. Pavese, A. Lisle, and M. Hockings. 2010. A Global Analysis of Protected Area Management Effectiveness. Environmental Management **46**:685–698. Available from http://link.springer.com/10.1007/s00267-010-9564-5.

Levin, S. A. 1998. Ecosystems and the Biosphere as Complex Adaptive Systems. Ecosystems **1**:431–436.

Levin, S. A. et al. 1998. Resilience in natural and socioeconomic systems. Environment and Development Economics **3 (2)**:221–262.

Lindsey, P. A., R. Alexander, M. G. L. Mills, S. Romañach, and R. Woodroffe. 2007. Wildlife Viewing Preferences of Visitors to Protected Areas in South Africa: Implications for the Role of Ecotourism in Conservation. Journal of Ecotourism **6**:19–33.

Lindsey, P. A., R. R. Alexander, J. T. Du Toit, and M. G. L. Mills. 2005. The potential contribution of ecotourism to African wild dog Lycaon pictus conservation in South Africa. Biological Conservation **123**:339–348.

Lindsey, P. A., V. R. Nyirenda, J. I. Barnes, M. S. Becker, R. McRobb, C. J. Tambling, W. A. Taylor, F. G. Watson, and M. T'Sas-Rolfes. 2014. Underperformance of African protected area networks and the case for new conservation models: Insights from Zambia. PLoS ONE **9**:e94109.

Lindsey, P. A., S. S. Romañach, and H. T. Davies-Mostert. 2009. The importance of conservancies for enhancing the value of game ranch land for large mammal conservation in southern Africa. Journal of Zoology **277**:99–105.

Liu, J. et al. 2007. Complexity of coupled human and natural systems. Science **317**:1513–1516.

Logan, S., and G. R. Wekerle. 2008. Neoliberalizing environmental governance? Land trusts, private conservation and nature on the Oak Ridges Moraine. Geoforum **39**:2097–2108. Elsevier Ltd. Available from http://dx.doi.org/10.1016/j.geoforum.2008.08.009.

Lombard, A. T., C. Hilton-Taylor, A. G. Rebelo, R. L. Pressey, and R. M. Cowling. 1999. Reserve selection in the Succulent Karoo, South Africa: coping with high compositional turnover. Plant Ecology **142**:35–55.

Loon, R. M., and D. Polakow. 2001. Ecotourism Ventures: Rags or Riches? Social Science Quarterly **28**:892–907.

Mace, G. M. 2014. Whose conservation? Science **345**:1558–1560.

Mace, G. M., K. Norris, and A. H. Fitter. 2012. Biodiversity and ecosystem services: A multilayered relationship. Trends in Ecology and Evolution **27**:19–25.

Maciejewski, K. 2014. Provincial Nature Reserves in the Western Cape. Unpublished Spatial Dataset.

Maciejewski, K., and G. S. Cumming. 2015. The Relevance of Socioeconomic Interactions for Resilience of Protected Area Networks. Ecosphere:In press. MS #ES15–00022; accepted 18th March 2015.

Maciejewski, K., A. De Vos, G. S. Cumming, C. Moore, and D. Bigg. 2015. Cross-scale feedbacks and scale mismatches as influences on cultural services and the resilience of protected areas. Ecological Applications **25**:11–23.

Maciejewski, K., and G. I. H. Kerley. 2014a. Understanding tourists' preference for mammal species in private protected areas: Is there a case for extralimital species for ecotourism? PLoS ONE **9**:e88192.

Maciejewski, K., and G. I. H. Kerley. 2014b. Elevated elephant density does not improve ecotourism opportunities: Convergence in social and ecological objectives. Ecological Applications **24**:920–926.

Magole, L. I., and L. Magole. 2011. Revisiting Botswana's High-Value, Low-Volume Tourism. Tourism Analysis **16**:203–210.

Margules, C. R., and R. L. Pressey. 2000. Systematic conservation planning. Nature **405**:243–253.

Martín-López, B. et al. 2012. Uncovering ecosystem service bundles through social preferences. PLoS ONE **7**.

Mascia, M. B., J. P. Brosius, T. A. Dobson, B. C. Forbes, L. Horowitz, M. A. McKean, and N. J. Turner. 2003. Conservation and the Social Sciences. Conservation Biology **17**:649–650.

Mascia, M. B., and S. Pailler. 2010. Protected area downgrading, downsizing, and degazettement (PADDD) and its conservation implications. Conservation Letters **4**:9–20.

May, R. M. 2006. Network structure and the biology of populations. Trends in Ecology and Evolution **21**:394–399.

McPherson, M., L. Smith-Lovin, and J. M. Cook. 2001. Birds of a feather: Homophily in social networks. Annual Review of Sociology:415–444.

Merenlender, A. M., L. Huntsinger, G. Guthey, and S. K. Fairfax. 2004. Land Trusts and Conservation Easements: Who Is Conserving What for Whom? Conservation Biology **18**:65–75.

Meyer, C., and G. Maree. 2013. State of Environment Outlook Report for the Western Cape Province.

Millennium Ecosystem Assessment. 2005. Ecosystems and Human Well-being: Synthesis. Island Press, Washington. Available from http://www.who.int/entity/globalchange/ecosystems/ecosys.pdf\nhttp://www.loc.gov/catdir/toc/ecip0512/2005013229.html.

Mills, M., J. G. Álvarez-Romero, K. Vance-Borland, P. Cohen, R. L. Pressey, A. M. Guerrero, and H. Ernstson. 2014. Linking regional planning and local action: Towards using social network analysis in systematic conservation planning. Biological Conservation **169**:6–13. Available from http://dx.doi.org/10.1016/j.biocon.2013.10.015.

Mir, D. D. F., and K. Dick. 2012. Conservation Approaches to Protecting Critical Habitats and Species on Private Property. Natural Areas Journal **32**:190–198.

Mitchell, B. 2005. Editorial. Parks **15**:1 – 5.

Moberg, F., and S. H. Simonsen. 2015. What is resilience? An introduction to social-ecological research. Stockholm Resilience Centre. Available from http://www.stockholmresilience.org/download/18.10119fc11455d3c557d6d21/1398172490555/SU_SRC_whatisresilience_sidaApril2014.pdf.

Moon, K., and C. Cocklin. 2011. A landholder-based approach to the design of private-land conservation programs. Conservation Biology **25**:493–503.

Mucina, L., and M. C. Rutherford. 2006. The vegetation of South Africa, Lesotho and Swaziland. Strelitzia 19. South African National Biodiversity Institute, Pretoria.

Musengezi, J., B. Child, and L. Racevskis. 2010. Profitability and policy of commercial wildlife use: game ranching in South Africa. University of Cape Town.

Myers, N., R. A. Mittermeier, G. A. B. Da Fonseca, and J. Kent. 2000. Biodiversity hotspots for conservation priorities. Nature **403**:853–8. Available from http://www.ncbi.nlm.nih.gov/pubmed/10706275.

Nagendra, H., S. Pareeth, B. Sharma, C. M. Schweik, and K. R. Adhikari. 2008. Forest fragmentation and regrowth in an institutional mosaic of community, government and private ownership in Nepal. Landscape Ecology **23**:41–54.

Naidoo, R., A. Balmford, P. J. Ferraro, S. Polasky, T. H. Ricketts, and M. Rouget. 2006. Integrating economic costs into conservation planning. Trends in Ecology and Evolution **21**:681–687.

NASA. 2015. SRTM v4. Available from http://www2.jpl.nasa.gov/srtm/cbanddataproducts.html.

Nassauer, J. I., M. V. Santelmann, and D. Scavia. 2007. From the Corn Belt to the gulf: societal and environmental implications of alternative agriculture futures. Resources for the Future, Washington.

Naughton-Treves, L., M. B. Holland, and K. Brandon. 2005. The Role of Protected Areas in Conserving Biodiversity and Sustaining Local Livelihoods. Annual Review of Environment and Resources **30**:219–252.

Neuvonen, M., E. Pouta, J. Puustinen, and T. Sievänen. 2010. Visits to national parks: Effects of park characteristics and spatial demand. Journal for Nature Conservation **18**:224–229.

Newburn, D., S. Reed, P. Berck, and A. Merenlender. 2005. Economics and land-use change in prioritizing private land conservation. Conservation Biology **19**:1411–1420.

Norberg, J., and G. S. Cumming. 2008. Complexity theory for a sustainable future. Columbia University Press, New York.

Norberg, J., J. Wilson, B. Walker, and E. Ostrom. 2008. Diversity and resilience of social-ecological systems. Pages 46–79 in J. Norberg and G. S. Cumming, editors. Complexity theory for a sustainable future.

Noss, R. F. 1990. Indicators for Monitoring Biodiversity : A Hierarchical Approach **4**:355–364.

Nyström, M., and C. Folke. 2001. Spatial resilience of coral reefs. Ecosystems **4**:406–417.

Ode, Å., M. S. Tveit, and G. Fry. 2008. Capturing Landscape Visual Character Using Indicators: Touching Base with Landscape Aesthetic Theory. Landscape Research **33**:89–117.

Oksanen, J., G. F. Blanchet, R. Kindt, P. Legendre, P. R. Minchin, R. B. O'Hara, G. L. Simpson, P. Solymos, M. H. H. Stevens, and H. Wagner. 2013. Package "vegan." Available from http://cran.ism.ac.jp/web/packages/vegan/vegan.pdf.

Olsson, P., C. Folke, and F. Berkes. 2004. Adaptive comanagement for building resilience in social-ecological systems. Environmental Management **34**:75–90.

Onal, H., and R. A. Briers. 2002. Incorporating spatial criteria in optimum reserve network selection. Proceedings. Biological sciences / The Royal Society **269**:2437–2441.

Opdam, P., E. Steingröver, and S. Van Rooij. 2006. Ecological networks: A spatial concept for multi-actor planning of sustainable landscapes. Landscape and Urban Planning **75**:322–332.

Ostrom, E. 1990. Governing the commons: The evolution of institutions for collective action. Cambridge University Press.

Ostrom, E., and H. Nagendra. 2007. Tenure alone is not sufficient: Monitoring is essential. Environmental Economics and Policy Studies **8**:175–199. Available from http://cat.inist.fr/?aModele=afficheN&cpsidt=19002782.

Palomo, I., C. Montes, B. Martín-López, J. A. González, M. García-Llorente, P. Alcorlo, and M. R. G. Mora. 2014. Incorporating the social-ecological approach in protected areas in the anthropocene. BioScience **64**:181–191.

Paloniemi, R., and P. M. Tikka. 2008. Ecological and social aspects of biodiversity conservation on private lands. Environmental Science and Policy **11**:336–346.

Pasquini, L. 2007. Privately-owned lands and biodiversity conservation: analysing the role of Private Conservation Areas in the Little Karoo, South Africa. University of Sheffield.

Pasquini, L., R. M. Cowling, C. Twyman, and J. Wainwright. 2009. Devising appropriate policies and instruments in support of private conservation areas: lessons learned from the Klein Karoo, South Africa. Conservation Biology **24**:470–478.

Pasquini, L., J. A. Fitzsimons, S. Cowell, K. Brandon, and G. Wescott. 2011. The establishment of large private nature reserves by conservation NGOs: key factors for successful implementation. Oryx **45**:373–380.

Pauchard, A., and P. Villarroel. 2002. Protected Areas in Chile : History , Current Status , and Challenges. Natural Areas Journal **22**:318–330.

Paulich, N. 2010. Increasing Private Conservation through Incentive Mechanisms. Journal of Animal Law and Policy **3**:105–158.

Pebesma, E., R. Bivand, B. Rowlingson, V. Gomez-Rubio, and R. Hijmans. 2014. Package “sp.” Available from http://cran.r-project.org/web/packages/sp/sp.pdf.

Pelling, M., and C. High. 2005. Understanding adaptation: What can social capital offer assessments of adaptive capacity? Global Environmental Change **15**:308–319.

Pence, G. Q. K. 2014. Western Cape Biodiversity Framework 2014 Update: Critical Biodiversity Areas of the Western Cape. Unpublished Cape Nature project report. Cape Town, South Africa. Available from http://bgis.sanbi.org/WCBF14/project.asp.

Pence, G. Q. K., M. A. Botha, and J. K. Turpie. 2003. Evaluating combinations of on-and off-reserve conservation strategies for the Agulhas Plain, South Africa: A financial perspective. Biological Conservation **112**:253–273.

Pickett, S. T. A., and M. L. Cadenasso. 1995. Landscape Ecology: Heterogeneity in Ecological Systems. Science (New York, N.Y.) **269**:331 – 334.

Pimm, S. L. 1991. The balance of nature?: ecological issues in the conservation of species and communities. The University of Chicago Press.

Pimm, S. L., and P. Raven. 2000. Extinction by numbers. Nature **403**:843–845.

Pouliquen-Young, O. 1997. Evolution of the system of protected areas in Western Australia. Environmental Conservation **June**:168–181.

Prato, T., and D. Fagre. 2005. National parks and protected areas : approaches for balancing social, economic, and ecological values. Blackwell, Ames, IA.

Pressey, R. L., T. C. Hager, K. M. Ryan, J. Schwarz, S. Wall, S. Ferrier, and P. M. Creaser. 2000. Using abiotic data for conservation assessments over extensive regions: Quantitative methods applied across New South Wales, Australia. Biological Conservation **96**:55–82.

Privett, S. D. J., B. J. Heydenrych, and R. M. Cowling. 2002. Putting biodiversity to business on the Agulhas Plain. Pages 101–115 in S. M. Pierce, R. M. Cowling, T. Sandwith, and K. MacKinnon, editors. Mainstreaming biodiversity in development: case studies from South Africa. The World Bank, Washington.

Proulx, S. R., D. E. L. Promislow, and P. C. Phillips. 2005. Network thinking in ecology and evolution. Trends in Ecology and Evolution **20**:345–353.

Prugh, L. R., K. E. Hodges, A. R. E. Sinclair, and J. S. Brashares. 2008. Effect of habitat area and isolation on fragmented animal populations. Proceedings of the National Academy of Sciences of the United States of America **105**:20770–20775.

Purnell, K. 2014. Stewardship Sites 2013. Unpublished Spatial Dataset.

Puustinen, J., E. Pouta, M. Neuvonen, and T. Sievänen. 2009. Visits to national parks and the provision of natural and man-made recreation and tourism resources. Journal of Ecotourism **8**.

Quintana, J., and S. Morse. 2005. Social interactions and resource ownership in two private protected areas of Paraguay. Journal of Environmental Management **77**:64–78.

R Core Development Team. 2014. R: A language and environment for statistical computing. Available from http://www.r-project.org/ (accessed March 6, 2015).

Ramutsindela, M. 2003. Land reform in South Africa’s national parks: a catalyst for the human–nature nexus. Land Use Policy **20**:41–49. Available from http://www.sciencedirect.com/science/article/pii/S0264837702000546.

Ramutsindela, M. 2004. Parks and People in Postcolonial Societies: Experiences in Southern Africa. Kluwer Academic Publishers.

Raudsepp-Hearne, C., G. D. Peterson, and E. M. Bennett. 2010. Ecosystem service bundles for analyzing tradeoffs in diverse landscapes. Proceedings of the National Academy of Sciences of the United States of America **107**:5242–5247.

Ravasz, E., and A.-L. Barabási. 2003. Hierarchical organization in complex networks. Physical Review E 67:026112.

Rayfield, B., M. J. Fortin, and A. Fall. 2011. Connectivity for conservation: A framework to classify network measures. Ecology **92**:847–858.

Raymond, C. M., and G. Brown. 2011. Assessing conservation opportunity on private land: Socio-economic, behavioral, and spatial dimensions. Journal of Environmental Management **92**:2513–2523. Elsevier Ltd. Available from http://dx.doi.org/10.1016/j.jenvman.2011.05.015.

Rebelo, A. G., and W. R. Siegfried. 1992. Where should nature reserves be located in the Cape Floristic Region, South Africa? Models for the spatial configuration of a reserve network aimed at maximizing the protection of floral diversity. Biological Conservation **6**:243 – 252.

Reinius, S. W., and P. Fredman. 2007. Protected areas as attractions. Annals of Tourism Research **34**:839–854.

Reyers, B. 2004. Incorporating anthropogenic threats into evaluations of regional biodiversity and prioritisation of conservation areas in the Limpopo Province, South Africa. Biological Conservation **118**:521–531.

Reyers, B., R. Biggs, G. S. Cumming, T. Elmqvist, A. P. Hejnowicz, and S. Polasky. 2013. Getting the measure of ecosystem services: A social-ecological approach. Frontiers in Ecology and the Environment **11**:268–273.

Reyers, B., S. Polasky, H. Tallis, H. A. Mooney, and A. Larigauderie. 2012. Finding Common Ground for Biodiversity and Ecosystem Services. BioScience **62**:503–507.

Reyers, B., D. J. Roux, R. M. Cowling, A. E. Ginsburg, J. L. Nel, and P. O. Farrell. 2010. Conservation planning as a transdisciplinary process. Conservation Biology **24**:957–965.

Richards, A. M. B., W. D. Stock, and R. M. Cowling. 2009. Soil nutrient dynamics and community boundaries of South Africa in the Fynbos vegetation. Plant Ecology **130**:143–153.

Rockström, J. et al. 2009. Exploring the Safe Operating Space for Humanity. Ecology And Society **14 (2)**:32.

Rogers, K. H. 2003. Adopting a heterogeneity paradigm: Implications for management of protected savannas. in J. T. du Toit, K. H. Rogers, and H. Biggs, editors. The Kruger Experience: Ecology and Management of Savanna Heterogeneity. Island Press, Washington.

Rogerson, C. 2006. Pro-Poor local economic development in South Africa: The role of pro-poor tourism. Local Environment **11**:37–60.

Rouget, M., D. M. Richardson, and R. M. Cowling. 2003a. The current configuration of protected areas in the Cape Floristic Region, South Africa - Reservation bias and representation of biodiversity patterns and processes. Biological Conservation **112**:129–145.

Rouget, M., D. M. Richardson, R. M. Cowling, J. W. Lloyd, and A. T. Lombard. 2003b. Current patterns of habitat transformation and future threats to biodiversity in terrestrial ecosystems of the Cape Floristic Region, South Africa. Biological Conservation **112**:63–85.

Runte, A. 1997. National Parks: the American experienceThird Edit. University of Nebraska Press.

SANBI. 2015. Western Cape Biomes. Available from http://bgis.sanbi.org/wces/biomes.asp (accessed February 20, 2015).

SANBI. 2016. SANBI BGIS 2016. Available from http://bgis.sanbi.org/projectsearch.asp (accessed January 21, 2016).

Sánchez-Azofeifa, A. G., G. C. Daily, A. S. P. Pfaff, and C. Busch. 2002. Integrity and isolation of Costa Rica's national parks and biological reserves: Examining the dynamics of land-cover change. Biological Conservation **109**:123–135.

SANParks. 2014. Annual Report 2013/2014. Available from http://www.sanparks.org/assets/docs/general/annual-report-2014.pdf.

SANParks. 2015. Parks (A-Z). Available from http://www.sanparks.co.za/parks/ (accessed March 3, 2015).

Schneider, A. 2015. GPS Visualizer. Available from http://www.gpsvisualizer.com/elevation (accessed December 15, 2014).

Scholes, R. J., and R. Biggs. 2004. Ecosystem services in southern Africa: a regional assessment. The regional scale component of the southern African Millennium Ecosystem Assessment. Council for Scientific and Industrial Research, Pretoria.

Scholes, R. J., B. Reyers, R. Biggs, M. J. Spierenburg, and A. Duriappah. 2013. Multi-scale and cross-scale assessments of social-ecological systems and their ecosystem services. Current Opinion in Environmental Sustainability **5**:16–25. Available from http://dx.doi.org/10.1016/j.cosust.2013.01.004.

Seddighi, H. R., and A. L. Theocharous. 2002. A model of tourism destination choice: A theoretical and empirical analysis. Tourism Management **23**:475–487.

Selinske, M. J., J. Coetzee, K. Purnell, and A. T. Knight. 2015. Understanding the Motivations, Satisfaction, and Retention of Landowners in Private Land Conservation Programs. Conservation Letters **8 (4)**:282–289. Available from http://doi.wiley.com/10.1111/conl.12154.

Shlens, J. 2005. A Tutorial on Principal Component Analysis. Measurement.

Sims-Castley, R., G. I. H. Kerley, B. Geach, and J. Langholz. 2005. Socio-economic significance of ecotourism-based private game reserves in South Africa's Eastern Cape Province. Parks **15**:6 – 18.

Smith, R. J., E. Di Minin, S. Linke, D. B. Segan, and H. P. Possingham. 2010. An approach for ensuring minimum protected area size in systematic conservation planning. Biological Conservation **143**:2525–2531. Elsevier Ltd. Available from http://dx.doi.org/10.1016/j.biocon.2010.06.019.

Snijders, D. 2012. Wild property and its boundaries – on wildlife policy and rural consequences in South Africa. Journal of Peasant Studies **39**:503–520.

Soderberg, K., and J. S. Compton. 2007. Dust as a nutrient source for fynbos ecosystems, South Africa. Ecosystems **10**:550–561.

Sorice, M. G., W. Haider, J. R. Conner, and R. B. Ditton. 2011. Incentive structure of and private landowner participation in an endangered species conservation program. Conservation Biology **25**:587–596.

Spenceley, A., and H. Goodwin. 2007. Nature-Based Tourism and Poverty Alleviation: Impacts of Private Sector and Parastatal Enterprises In and Around Kruger National Park, South Africa. Current Issues in Tourism **10**:255–277.

Spenceley, A., J. Kohl, S. Mcarthur, P. Myles, M. Notarianni, D. Paleczny, C. Pickering, and G. L.

Worboys. 2015. Visitor Management. Protected Area Governance and Management.

Spenceley, A., and D. Meyer. 2012a. Tourism and poverty reduction: theory and practice in less economically developed countries. Journal of Sustainable Tourism **20**:297–317. Available from http://shura.shu.ac.uk/5997/.

Spenceley, A., and D. Meyer. 2012b. Tourism and poverty reduction: theory and practice in less economically developed countries. Journal of Sustainable Tourism **20**:297–317.

Spenceley, A., P. Relly, H. Keyser, M. Mckenzie, A. Mataboge, P. Norton, and S. Mahlangu. 2002. Responsible Tourism Manual for South Africa. Department for Environmental Affairs and Tourism **July 2002**. Available from http://www.kruger2canyons.org/031 - Responsible Tourism Manual.pdf (accessed October 6, 2015).

Spenceley, A., and J. Seif. 2003. Strategies, Impacts and Costs of Pro-Poor Tourism Approaches in South Africa:42.

Spierenburg, M., C. Steenkamp, and H. Wels. 2012. Enclosing the Local for the Global Commons : Community Land Rights in the Great Limpopo Transfrontier Conservation Area. Conservation and Society **6**:87–97.

Steffen, W. et al. 2004. Abrupt changes - The Achilles' heel of the Earth System. Environment **46**:20.

Stockholm Resilience Centre. 2015. What is resilience? Available from http://www.stockholmresilience.org/21/research/research-news/2-19-2015-what-is-resilience.html (accessed January 16, 2016).

Stolton, S., K. H. Redford, and N. Dudley. 2014. The Futures of Privately Protected Areas. Gland, Switzerland: IUCN. Available from https://portals.iucn.org/library/sites/library/files/documents/PATRS-001.pdf (accessed October 6, 2015).

Sundaresan, S. R., and C. Riginos. 2010. Lessons learned from biodiversity conservation in the private lands of Laikipia, Kenya. Great Plains Research **20**:17–27.

Sutherland, W. J. et al. 2009. One hundred questions of importance to the conservation of global biological diversity. Conservation Biology **23**:557–567.

Tecklin, D. R., and C. Sepulveda. 2014. The Diverse Properties of Private Land Conservation in Chile : Growth and Barriers to Private Protected Areas in a Market - friendly Context. Conservation and Society **12**:203–217.

Thondhlana, G., S. Shackleton, and E. Muchapondwa. 2011. Kgalagadi Transfrontier Park and its land claimants: a pre- and post-land claim conservation and development history. Environmental Research Letters **6**:024009.

Tilman, D., and J. A. Downing. 1994. Biodiversity and stability in grasslands. Nature **367**:363–365.

Turner, A. A. 2012. Western Cape Province State of Biodiversity 2012. Cape Nature Scientific Services, Stellenbosch.

Turner, N. J., I. J. Davidson-Hunt, and M. O'Flaherty. 2003. Living on the edge: Ecological and cultural edges as sources of diversity for social-ecological resilience. Human Ecology **31**:439–462.

Turner, R. L. 2004. Communities, Wildlife Conservation, and Tourism-Based Development: Can Community-Based Nature Tourism Live Up To Its Promise? Journal of International Wildlife Law & Policy **7**:161–182. Available from http://www.tandfonline.com/doi/abs/10.1080/13880290490883232.

UN. 2015. Millennium Development Goals and Beyond 2015. Available from http://www.un.org/millenniumgoals/ (accessed January 17, 2015).

United Nations. 2015. Global Sustainable Development Report. Available from https://sustainabledevelopment.un.org/content/documents/1758GSDR 2015 Advance Unedited Version.pdf.

Urban, D., and T. Keitt. 2001. Landscape Connectivity : A Graph-Theoretic Perspective. Ecology **82**:1205–1218.

Van den Berg, E. C., C. Plarre, and M. W. Thompson. 2008. The South African National Land Cover 2000. Report No. GW/A/2008/86. Pretoria.

Van der Merwe, P., and M. Saayman. 2003. Determining the economic value of game farm tourism. Koedoe **46**:103–112.

Van der Merwe, P., and M. Saayman. 2005. Game farms as sustainable ecotourist attractions. Koedoe **48**:1–10.

Van der Waal, C., and B. Dekker. 2000. Game Ranching in the Northern Province of South Africa. South African Journal of Wildlife Research **30**:151–156.

van Jaarsveld, A. S., R. Biggs, R. J. Scholes, E. Bohensky, B. Reyers, T. Lynam, C. Musvoto, and C. Fabricius. 2005. Measuring conditions and trends in ecosystem services at multiple scales: the Southern African Millennium Ecosystem Assessment (SAfMA) experience. Philosophical transactions of the Royal Society of London. Series B, Biological Sciences **360**:425–441.

Vance-Borland, K., and J. Holley. 2011. Conservation stakeholder network mapping, analysis, and weaving. Conservation Letters **4**:278–288.

Vimal, R., R. Mathevet, and J. D. Thompson. 2012. The changing landscape of ecological networks. Journal for Nature Conservation **20**:49–55. Elsevier GmbH. Available from http://dx.doi.org/10.1016/j.jnc.2011.08.001.

Von Hase, A., M. Rouget, and R. M. Cowling. 2010. Evaluating private land conservation in the cape lowlands, South Africa. Conservation Biology **24**:1182–1189.

Walker, B., L. Gunderson, A. Kinzig, C. Folke, S. Carpenter, and L. Schultz. 2006. A handful of heuristics and some propositions for understanding resilience in social-ecological systems. Ecology and Society **11 (1)**:13.

Walker, B. H. 1981. Is Succession a Viable Concept in African Savanna Ecosystems? Pages 431–447 in D. C. West, H. H. Shugart, and D. B. Botkin, editors. Forest succession. Concepts and application. Springer New York.

Walker, B., C. S. Holling, S. R. Carpenter, and A. Kinzig. 2004. Resilience , Adaptability and Transformability in Social – Ecological Systems. Ecology And Society **9**:5. Available from http://fiesta.bren.ucsb.edu/~gsd/resources/courses/Walker.pdf.

Weaver, D. B., and L. J. Lawton. 2007. Twenty years on: The state of contemporary ecotourism research. Tourism Management **28**:1168–1179.

Webb, C., and Ö. Bodin. 2008. A network perspective on modularity and control of flow in robust systems. Pages 85 – 111 in J. Norberg and G. S. Cumming, editors. Complexity theory for a sustainable future. Columbia University Press.

West, P., J. Igoe, and D. Brockington. 2006. Parks and Peoples: The Social Impact of Protected Areas. Annual Review of Anthropology **35**:251–277.

Western Cape Government. 2015. Western Cape Nature Reserves. Available from http://www.westerncape.gov.za/service/western-cape-nature-reserves (accessed January 17, 2015).

Westley, F., S. R. Carpenter, W. A. Brock, C. S. Holling, and L. H. Gunderson. 2002. Why systems of pople and nature are not just social and ecological systems. Pages 103–119 in L. H. Gunderson and C. S. Holling, editors. Panarchy: Understanding Transformation in Human and Natural Systems. Island Press, Washington.

Westley, F. R., O. Tjornbo, L. Schultz, P. Olsson, C. Folke, B. Crona, and Ö. Bodin. 2013. A theory of transformative agency in linked social-ecological systems. Ecology and Society **18**.

Whitehead, A. L., H. Kujala, C. D. Ives, A. Gordon, P. E. Lentini, B. A. Wintle, E. Nicholson, and C. M. Raymond. 2014. Integrating biological and social values when prioritizing places for biodiversity conservation. Conservation Biology **28**:992–1003.

Whittaker, R. J., M. B. Araujo, P. Jepson, R. J. Ladle, J. E. M. Watson, and K. J. Willis. 2005. Conservation biogeography: asessment and prospect. Diversity and Distributions **11**:3–23.

Wickham, H., and W. Chang. 2015. Package "ggplot2." Available from http://cran.r-project.org/web/packages/ggplot2/ggplot2.pdf.

Wilson, K. A. et al. 2007. Conserving biodiversity efficiently: What to do, where, and when. PLoS Biology **5**:1850–1861.

Wilson, M. A., and R. B. Howarth. 2002. Discourse-based valuation of ecosystem services: Establishing fair outcomes through group deliberation. Ecological Economics **41**:431–443.

Wolff, S., C. Schulp, and P. H. Verburg. 2015. Mapping ecosystem services demand: A review of current research and future perspectives. Ecological Indicators **55**:159–171.

Wolmer, W. 2005. Wilderness gained, wilderness lost: Wildlife management and land occupations in Zimbabwe's southeast lowveld. Journal of Historical Geography **31**:260–280.

World Parks Congress. 2014. IUCN World Parks Congress Sydney 2014. Available from http://worldparkscongress.org/ (accessed June 5, 2015).

Wu, J. 2013. Landscape sustainability science: Ecosystem services and human well-being in changing landscapes. Landscape Ecology **28**:999–1023.

WWF South Africa. 2015. Biodiversity and Wine. Available from http://www.wwf.org.za/what_we_do/sustainable_agriculture_/biodiversity___wine_initiative/ (accessed January 17, 2015).

Xu, R., and D. Wunsch II. 2005. Servey of Clustering Algorithms. IEEE Transactions on Neural Networks **16**.

Young, O. R. 2001. The behavioral effects of environmental regimes: colletive actions vs social-practice models. International Environmental Agreements: Politics, Law and Economics **1**:9–29.

Zuur, A. F., E. N. Ieno, and C. S. Elphick. 2010. A protocol for data exploration to avoid common statistical problems. Methods in Ecology and Evolution **1**:3–14. Available from http://doi.wiley.com/10.1111/j.2041-210X.2009.00001.x.

Appendix

Appendix 1: General Questionnaire for personal interviews with Private Protected Areas in the Western Cape

Private Protected Area Networks in the Cape, South Africa

General Questionnaire

This questionnaire is part of the research for a PhD in Conservation Biology. The project focuses on understanding the influence of geographical location on private protected areas and the functioning of their network in the Cape, South Africa. Results from this interview will be used to analyse social and ecological characteristics of your park and your interactions with other entities. Desired outcomes of the project are an inventory and maps of private conservation action as well as policy recommendations for conservation planning regarding biodiversity and ecosystem services provision.

My study strongly relies on your support and active participation. Your fully completed interview is of essential value to a comprehensive analysis and successful proceeding. Any information provided in this interview will be kept confidential. In return I will provide you with results which aim to be of value to the management and marketing of your reserve.

Completion of the questionnaire:
You are kindly asked to complete this questionnaire during a personal discussion with me. Please provide answers to every question. If a question does not apply to your individual situation 'NA' should be ticked; if you don't know an answer at the time of being asked 'DK' should be ticked. Additional data, information or suggestions are welcome any time and should be submitted to me using the contact details above.

Thank you for your active participation and contribution!

Location code: ______________________ Interviewer: ____________________________

Date & duration of interview: _________________________________

Personal data:

Name code: ____

Your position in the park: ____

Your age and gender: ____

Your background, origin: ____

Your education & profession: ____

____

How / when did you join the park? ____

____

Park background:

When was the park established? ____ □ DK

What is the legal/registered status of the park (definition)? ______________________

____ □ DK

How big is the park (area)? ____ □ DK

How many individual properties were merged to establish the park? ______________

____ □ DK

What was the ownership and land use of the area(s) before establishment of the reserve?

Ownership: □ private □ communal □ state □ DK

Usage: □ farmland (crops) □ farmland (cattle) □ forestry □ unused biotopes
□ other (please specify): _________________________ □ DK

Intensity of usage:
□ very low □ low □ medium □ high □ very high □ DK □ NA

please specify: ____

____

Did the current owner of the park change the previous land use into a nature reserve?
□ yes □ no □ DK

Due to which purpose was the area originally established?
Please rank on a scale from 1 (not relevant) to 5 (very important):

	1	**2**	**3**	**4**	**5**	**DK**
Business, economic reason	□	□	□	□	□	□
Research	□	□	□	□	□	□
Conservation	□	□	□	□	□	□
Education	□	□	□	□	□	□
Family history	□	□	□	□	□	□
Other: ____________________________	□	□	□	□	□	□

How many staff members are employed?

□ small: 0 – 10 □ medium: 11 – 25 □ large: 26 – 50 □ very large: >51

Number: _____________________ □ DK

How many staff members employed originate/live within a 50 km distance to your park?

□ none □ single persons □ several (< 25%) □ many (25 – 50%)

□ mainly (> 50%) Number: _____________________ □ DK

How many staff members belong to the following groups:

Black background	*White*	*Coloured*	*other ethnical*
□ none	□ none	□ none	□ none
□ single persons	□ single persons	□ single persons	□ single persons
□ several (< 25%)	□ several (< 25%)	□ several (< 25%)	□ several (< 25%)
□ many (25 – 50%)	□ many (25 – 50%)	□ many (25 – 50%)	□ many (25 – 50%)
□ mainly (> 50%)	□ mainly (> 50%)	□ mainly (> 50%)	□ mainly (> 50%)
□ DK	□ DK	□ DK	□ DK
Number: ______	_______	______	______

Which is the highest employment category of your employees regarding ethnical groups?

Black background	*White*	*Coloured*	*other ethnical*
□ maintenance	□ maintenance	□ maintenance	□ maintenance
□ service	□ service	□ service	□ service
□ management	□ management	□ management	□ management
□ other: ______________	□ other: ______________	□ other: ______________	□ other: ______________
□ DK	□ DK	□ DK	□ DK

Economic conditions: Which type of income currently sustains the park?
Please rank on a scale from 1 (not relevant) to 5 (very important):

	1	**2**	**3**	**4**	**5**	**DK**	**NA**
Tourism (viewing):							
mammals	□	□	□	□	□	□	□
birds	□	□	□	□	□	□	□
other: _____________________	□	□	□	□	□	□	□
Education	□	□	□	□	□	□	□
Biltong hunting	□	□	□	□	□	□	□
Trophy hunting	□	□	□	□	□	□	□
Fishing	□	□	□	□	□	□	□

Wildlife trade	☐	☐	☐	☐	☐	☐	☐
Events (conferences, weddings…)	☐	☐	☐	☐	☐	☐	☐
Accommodation	☐	☐	☐	☐	☐	☐	☐
Restaurant	☐	☐	☐	☐	☐	☐	☐
Shop	☐	☐	☐	☐	☐	☐	☐
Natural products: _______________________	☐	☐	☐	☐	☐	☐	☐
Other income: _________________________	☐	☐	☐	☐	☐	☐	☐
Other investment: _______________________	☐	☐	☐	☐	☐	☐	☐

<u>Please</u> complete the additional financial questionnaire provided later, thank you.

<u>Location:</u>

How important are the following conditions during ***establishment*** *of a private protected area? Please rank on a scale from 1 (not relevant) to 5 (very important):*

	1	**2**	**3**	**4**	**5**	**DK**
Ecosystems/ biophysical conditions	☐	☐	☐	☐	☐	☐
Species richness/ endemism/ endangerment	☐	☐	☐	☐	☐	☐
Connectivity	☐	☐	☐	☐	☐	☐
Big 5 suitable habitat	☐	☐	☐	☐	☐	☐
Conservation priorities/scientific assessment	☐	☐	☐	☐	☐	☐
Other: _________________________________	☐	☐	☐	☐	☐	☐
Ecological conditions (generally):	☐	☐	☐	☐	☐	☐
Infrastructure/ accessibility (proximity to cities, airports, roads, suppliers etc.)	☐	☐	☐	☐	☐	☐
Land prices	☐	☐	☐	☐	☐	☐
Legislation/ bureaucracy	☐	☐	☐	☐	☐	☐
Labour market conditions	☐	☐	☐	☐	☐	☐
Other: _________________________________	☐	☐	☐	☐	☐	☐
Socioeconomic conditions (generally):	☐	☐	☐	☐	☐	☐
Adjacent neighbours	☐	☐	☐	☐	☐	☐
Adjacent communities	☐	☐	☐	☐	☐	☐
Proximity to National Parks	☐	☐	☐	☐	☐	☐
Other private areas	☐	☐	☐	☐	☐	☐
Public protected areas	☐	☐	☐	☐	☐	☐
Institutions/ organisations: _______________	☐	☐	☐	☐	☐	☐
Competition	☐	☐	☐	☐	☐	☐
Collaboration	☐	☐	☐	☐	☐	☐
Other: _________________________________	☐	☐	☐	☐	☐	☐
Connections/ network (generally):	☐	☐	☐	☐	☐	☐

*How important are the following conditions for the **maintenance/ running/ tourism** of a private protected area? Please rank on a scale from 1 (not relevant) to 5 (very important):*

	1	**2**	**3**	**4**	**5**	**DK**
Ecosystems/ biophysical conditions	☐	☐	☐	☐	☐	☐
Species richness/ endemism/ endangerment	☐	☐	☐	☐	☐	☐
Connectivity	☐	☐	☐	☐	☐	☐
Big 5 suitable habitat	☐	☐	☐	☐	☐	☐
Conservation priorities/scientific assessment	☐	☐	☐	☐	☐	☐
Other: _______________________________	☐	☐	☐	☐	☐	☐
Ecological conditions (generally):	☐	☐	☐	☐	☐	☐
Infrastructure/ accessibility (proximity to cities, airports, roads, suppliers etc.)	☐	☐	☐	☐	☐	☐
Land prices	☐	☐	☐	☐	☐	☐
Legislation/ bureaucracy	☐	☐	☐	☐	☐	☐
Labour market conditions	☐	☐	☐	☐	☐	☐
Other: _______________________________	☐	☐	☐	☐	☐	☐
Socioeconomic conditions (generally):	☐	☐	☐	☐	☐	☐
Adjacent neighbours	☐	☐	☐	☐	☐	☐
Adjacent communities	☐	☐	☐	☐	☐	☐
Proximity to National Parks	☐	☐	☐	☐	☐	☐
Other private areas	☐	☐	☐	☐	☐	☐
Public protected areas	☐	☐	☐	☐	☐	☐
Institutions/ organisations: _______________	☐	☐	☐	☐	☐	☐
Competition	☐	☐	☐	☐	☐	☐
Collaboration	☐	☐	☐	☐	☐	☐
Other: _______________________________	☐	☐	☐	☐	☐	☐
Connections/ network (generally):	☐	☐	☐	☐	☐	☐

*How important are the following conditions for the **collaboration/ network** of a private protected area? Please rank on a scale from 1 (not relevant) to 5 (very important):*

	1	**2**	**3**	**4**	**5**	**DK**
Ecosystems/ biophysical conditions	☐	☐	☐	☐	☐	☐
Species richness/ endemism/ endangerment	☐	☐	☐	☐	☐	☐
Connectivity	☐	☐	☐	☐	☐	☐
Big 5 suitable habitat	☐	☐	☐	☐	☐	☐
Conservation priorities/scientific assessment	☐	☐	☐	☐	☐	☐
Other: _______________________________	☐	☐	☐	☐	☐	☐
Ecological conditions (generally):	☐	☐	☐	☐	☐	☐
Infrastructure/ accessibility (proximity to cities, airports, roads, suppliers etc.)	☐	☐	☐	☐	☐	☐
Land prices	☐	☐	☐	☐	☐	☐
Legislation/ bureaucracy	☐	☐	☐	☐	☐	☐
Labour market conditions	☐	☐	☐	☐	☐	☐

Other: ______________________________	□	□	□	□	□	□
Socioeconomic conditions (generally):	□	□	□	□	□	□
Adjacent neighbours	□	□	□	□	□	□
Adjacent communities	□	□	□	□	□	□
Proximity to National Parks	□	□	□	□	□	□
Other private areas	□	□	□	□	□	□
Public protected areas	□	□	□	□	□	□
Institutions/ organisations: _______________	□	□	□	□	□	□
Competition	□	□	□	□	□	□
Collaboration	□	□	□	□	□	□
Other: ______________________________	□	□	□	□	□	□
Connections/ network (generally):	□	□	□	□	□	□

If it was possible, would you expand the area of your park or do you currently plan to do so?
□ yes □ no □ DK

What would affect your decision to expand the park most? Please rank on a scale from 1 (not relevant) to 5 (very important):

	1	**2**	**3**	**4**	**5**	**DK**
Suitable/rare ecosystems/ biophysical conditions	□	□	□	□	□	□
High species richness/ endemism/ endangerment	□	□	□	□	□	□
Connectivity: as aim	□	□	□	□	□	□
Good infrastructure/ accessibility	□	□	□	□	□	□
Land prices: high, as constraint	□	□	□	□	□	□
Land prices: low, as encouragement	□	□	□	□	□	□
Legislation: as constraint	□	□	□	□	□	□
Legislation: as encouragement	□	□	□	□	□	□
Conservation objectives	□	□	□	□	□	□
Adjacent neighbours: as constraint	□	□	□	□	□	□
Adjacent neighbours: as encouragement	□	□	□	□	□	□
Other entities: as constraint	□	□	□	□	□	□
Other entities: as encouragement	□	□	□	□	□	□
Personal wish/ aim	□	□	□	□	□	□
Income increase	□	□	□	□	□	□
Other (please specify): ____________________	□	□	□	□	□	□

<u>Ecology:</u>

Are you willing and able to tell me stocking rates of your wildlife (big mammals)?

□ yes □ no □ DK

If yes, please provide figures as detailed as possible or even a digital data set if possible. Thank you!

How important do you consider each of the following ecological features to be in your park? Please rank on a scale from 1 (not relevant) to 5 (very important):

	1	2	3	4	5	DK	NA
Big mammals	☐	☐	☐	☐	☐	☐	☐
Big 5	☐	☐	☐	☐	☐	☐	☐
Birds	☐	☐	☐	☐	☐	☐	☐
Reptiles	☐	☐	☐	☐	☐	☐	☐
Insects	☐	☐	☐	☐	☐	☐	☐
Fish	☐	☐	☐	☐	☐	☐	☐
Vegetation	☐	☐	☐	☐	☐	☐	☐
Geology/Soil	☐	☐	☐	☐	☐	☐	☐
Endemic species: ____________________	☐	☐	☐	☐	☐	☐	☐
Migrating species: ____________________	☐	☐	☐	☐	☐	☐	☐
Endangered species: __________________	☐	☐	☐	☐	☐	☐	☐
Other: ______________________________	☐	☐	☐	☐	☐	☐	☐

How important do you consider the following habitat types to be in your park?
Please rank on a scale from 1 (not relevant) to 5 (very important):

	1	2	3	4	5	DK	NA
Aquatic system (river, lake, bog)	☐	☐	☐	☐	☐	☐	☐
Coastal habitat (dunes)	☐	☐	☐	☐	☐	☐	☐
Marine system	☐	☐	☐	☐	☐	☐	☐
Forest	☐	☐	☐	☐	☐	☐	☐
Fynbos	☐	☐	☐	☐	☐	☐	☐
Grassland	☐	☐	☐	☐	☐	☐	☐
Savanna	☐	☐	☐	☐	☐	☐	☐
Karoo	☐	☐	☐	☐	☐	☐	☐
Mountainous habitat	☐	☐	☐	☐	☐	☐	☐
Thicket	☐	☐	☐	☐	☐	☐	☐
Other: ______________________________	☐	☐	☐	☐	☐	☐	☐

Do you perform own research on-site?
☐ yes ☐ no ☐ DK

If yes: please specify: since when____

about what ____

specialized staff ____

If no: *Do you obtain income from researchers using your area?*

☐ yes (please explain) : ____
☐ no ☐ DK

Do you have GIS layers of the area or other research data? □ yes □ no □ DK
Available to us? □ yes □ no □ DK

Do invasive plant species occur in the park?
□ yes □ no □ DK

If yes: please specify: which species ____

since when ____

impact caused ____

your action ____

Do you experience other ecological problems (e.g. pollution, soil erosion)?

□ yes: ____

____

□ no □ DK

Do you buy or sell wildlife?
□ yes □ no □ DK

If yes: please specify: which species ____

how and where (e.g. auction) __________________________________

____

how often/many____

Do you have predators in your park? □ yes □ no □ DK

How do you manage them? (fence, collar) ____

____

Do you have anti-poaching activities in your park? □ yes □ no □ DK

If yes, please specify: ____

____

Do you perform rehabilitation of animals or do you accept/release rehabilitated animals?
□ yes □ no □ DK

If yes: please specify: which species ____

from whom ____

how often ____

Do you permit hunting in the park?
□ yes □ no □ DK

If yes: □ biltong hunting □ trophy hunting

please specify: which species ____

intensity ____

Do you regulate wildlife populations?
□ yes □ no □ DK

If yes: please specify: which species ____

how ____

Do any 'problem animals' occur in your park?
□ yes □ no □ DK

If yes: please specify: which species ____

problem caused ____

your reaction ____

Tourism:

How many visitors per year? _______________________________ □ DK

Please rank the following seasons regarding visiting rates to your park and provide average amounts for each season if possible:

	low	**medium**	**high**	**DK**
Spring	□	□	□	□
Summer	□	□	□	□
Autumn	□	□	□	□
Winter	□	□	□	□

Average amounts of visitors per season:

Spring ____________ Summer ____________

Autumn ___________ Winter _____________ ◻ DK

How many visitors belong to the following categories? Please tick and also give precise percentages if possible:

	>75%	**about half**	**<25%**	**percentage**	**DK**
International	◻	◻	◻	_____%	◻
National	◻	◻	◻	_____%	◻

How many of the national visitors belong to the following categories? Please tick and also give precise percentages if possible:

	>75%	**about half**	**<25%**	**percentage**	**DK**
Whole South Africa	◻	◻	◻	_____%	◻
Provincial	◻	◻	◻	_____%	◻
Local	◻	◻	◻	_____%	◻

Do you advertise, perform any marketing?
◻ yes ◻ no ◻ DK

If yes: ◻ website ◻ brochures ◻ ads in newspapers ◻ agent

◻ other: ____

Spatial range of advertisements:

	local (<50km)	**provincial**	**national**	**international**	**DK**	**NA**
Website	◻	◻	◻	◻	◻	◻
Brochures	◻	◻	◻	◻	◻	◻
Ads	◻	◻	◻	◻	◻	◻
Agent	◻	◻	◻	◻	◻	◻
Other: ___________	◻	◻	◻	◻	◻	◻

Which location do your visitors come from and go to after staying with you? Please provide approximate percentages:

	Come from	**Go to**	**DK**
National parks :	_____%	_____%	◻
Private parks:	_____%	_____%	◻
Home/park only destination:	_____%	_____%	◻

Other activities:	_____%	_____%	□

How far do visitors generally travel on their trip within South Africa? Please rank on a scale from 1 (not appropriate) to 5 (very appropriate):

	1	2	3	4	5	DK
In close proximity, rather locally	□	□	□	□	□	□
In further distance, rather nationally	□	□	□	□	□	□

Which kind of social facilities and activities do you provide?

□ guided tours (walks, drives etc.) □ restaurant □ shop
□ accommodation □ camping □ education
□ day-time access □ children's care □ weddings
□ conference rooms □ fishing □ trophy hunting
□ biltong hunting □ birding □ other: ___________________________

How do these social facilities rank in importance to your visitors, according to your experience/opinion? Please rank on a scale from 1 (not relevant) to 5 (very important):

	1	2	3	4	5	DK	NA
Guided tours	□	□	□	□	□	□	□
Restaurant	□	□	□	□	□	□	□
Shop	□	□	□	□	□	□	□
Accommodation	□	□	□	□	□	□	□
Camping	□	□	□	□	□	□	□
Education	□	□	□	□	□	□	□
Day-time access	□	□	□	□	□	□	□
Children's care	□	□	□	□	□	□	□
Trophy hunting	□	□	□	□	□	□	□
Biltong hunting	□	□	□	□	□	□	□
Conference rooms	□	□	□	□	□	□	□
Weddings	□	□	□	□	□	□	□
Fishing	□	□	□	□	□	□	□
Birding	□	□	□	□	□	□	□
Other: ___________________________	□	□	□	□	□	□	□

Based on your perception, how do the ecological features of your park generally rank to your visitors? Please rank on a scale from 1 (not relevant) to 5 (very important):

	1	2	3	4	5	DK	NA
Big mammals	□	□	□	□	□	□	□
Big 5	□	□	□	□	□	□	□
Birds	□	□	□	□	□	□	□
Reptiles	□	□	□	□	□	□	□
Insects	□	□	□	□	□	□	□

Fish	☐	☐	☐	☐	☐	☐	☐
Vegetation	☐	☐	☐	☐	☐	☐	☐
Geology/Soil	☐	☐	☐	☐	☐	☐	☐
Endemic species	☐	☐	☐	☐	☐	☐	☐
Migrating species	☐	☐	☐	☐	☐	☐	☐
Endangered species	☐	☐	☐	☐	☐	☐	☐
Other: ______________________________	☐	☐	☐	☐	☐	☐	☐

Based on your perception, how do the habitats of your park generally rank to your visitors? Please rank on a scale from 1 (not relevant) to 5 (very important):

	1	**2**	**3**	**4**	**5**	**DK**	**NA**
Aquatic system (river, lake, bog)	☐	☐	☐	☐	☐	☐	☐
Coastal habitat (dunes)	☐	☐	☐	☐	☐	☐	☐
Marine system	☐	☐	☐	☐	☐	☐	☐
Forest	☐	☐	☐	☐	☐	☐	☐
Fynbos	☐	☐	☐	☐	☐	☐	☐
Grassland	☐	☐	☐	☐	☐	☐	☐
Savanna	☐	☐	☐	☐	☐	☐	☐
Karoo	☐	☐	☐	☐	☐	☐	☐
Mountainous habitat	☐	☐	☐	☐	☐	☐	☐
Thicket	☐	☐	☐	☐	☐	☐	☐
Other: _______________________________	☐	☐	☐	☐	☐	☐	☐

Based on your perception, for which purpose do your visitors come to your park? Please rank on a scale from 1 (not relevant) to 5 (very important):

	1	**2**	**3**	**4**	**5**	**DK**
Feeling connected to **upbringing**	☐	☐	☐	☐	☐	☐
Feeling connected to **religion / spirituality**	☐	☐	☐	☐	☐	☐
Feeling **connected** to the natural world	☐	☐	☐	☐	☐	☐
Learning about the world around them	☐	☐	☐	☐	☐	☐
Being **inspired** by the natural world	☐	☐	☐	☐	☐	☐
Identifying **aesthetic value** in the world around them	☐	☐	☐	☐	☐	☐
Better understanding of **social relations**	☐	☐	☐	☐	☐	☐

Sense of place identification	□	□	□	□	□	□
Better identifying with **culture / themselves**	□	□	□	□	□	□
Recreation / health issues	□	□	□	□	□	□

Do you collect data about tourism in your park? □ yes □ no □ DK

Are you able / willing to make them available to us? □ yes □ no □ DK

Interactions:

Do you interact with other entities?

□ yes □ no □ DK

If yes: □ private park □ national park □ association
□ community □ company □ research institution
□ educational institution □ trade union □ government

□ other: ____

Please list: ***5 names of entities of any type*** *you mainly interact with regarding your job/ position in the park, since when you interact (previous to current job or earlier, year if possible), how and how frequent:*

	Since	**Personal**	**Indirect**	**Occasional**	**Frequent**
1____________________	_____________	□	□	□	□
2____________________	_____________	□	□	□	□
3____________________	_____________	□	□	□	□
4____________________	_____________	□	□	□	□
5____________________	_____________	□	□	□	□

Please tick the topics/ type of interaction you have with these 5 entities:

	Entity: **1**	**2**	**3**	**4**	**5**
Employment	□	□	□	□	□
Research	□	□	□	□	□
Marketing/ exchange of advertisement	□	□	□	□	□
Collaboration (knowledge transfer)	□	□	□	□	□
Collaboration (resource transfer)	□	□	□	□	□
Education	□	□	□	□	□
Wildlife	□	□	□	□	□
Tourism	□	□	□	□	□

Legislation/ bureaucracy	☐	☐	☐	☐	☐
Finances	☐	☐	☐	☐	☐
Supply/ equipment	☐	☐	☐	☐	☐
Other: ___________________________	☐	☐	☐	☐	☐
DK	☐	☐	☐	☐	☐

How do you mainly communicate with these 5 entities? Please tick.

	Entity: **1**	**2**	**3**	**4**	**5**
Telephone	☐	☐	☐	☐	☐
Email	☐	☐	☐	☐	☐
Post	☐	☐	☐	☐	☐
Internet, Social Media	☐	☐	☐	☐	☐
Visits	☐	☐	☐	☐	☐
Other: ____________________________	☐	☐	☐	☐	☐
DK	☐	☐	☐	☐	☐

*Please list **5 other protected areas** you yourself regarding your job/ position mainly interact with, since when you interact and how frequent:*

	Since	**Personal / Indirect**		**Occasional / Frequent**	
1____________________	_____________	☐	☐	☐	☐
2____________________	_____________	☐	☐	☐	☐
3____________________	_____________	☐	☐	☐	☐
4____________________	_____________	☐	☐	☐	☐
5____________________	_____________	☐	☐	☐	☐

Please specify the topic/ type of interaction you have with these 5 protected areas:

	Area: **1**	**2**	**3**	**4**	**5**
Employment	☐	☐	☐	☐	☐
Research	☐	☐	☐	☐	☐
Marketing/ exchange of advertisement	☐	☐	☐	☐	☐
Collaboration (knowledge transfer)	☐	☐	☐	☐	☐
Collaboration (resource transfer)	☐	☐	☐	☐	☐
Education	☐	☐	☐	☐	☐
Wildlife	☐	☐	☐	☐	☐
Tourism	☐	☐	☐	☐	☐
Legislation/ bureaucracy	☐	☐	☐	☐	☐
Finances	☐	☐	☐	☐	☐
Supply/ equipment	☐	☐	☐	☐	☐
Other: ___________________________	☐	☐	☐	☐	☐
DK	☐	☐	☐	☐	☐

How do you mainly communicate with these 5 protected areas?

Area:	**1**	**2**	**3**	**4**	**5**
Telephone	□	□	□	□	□
Email	□	□	□	□	□
Post	□	□	□	□	□
Internet, Social Media	□	□	□	□	□
Visits	□	□	□	□	□
Other: ____________________________	□	□	□	□	□
DK	□	□	□	□	□

Please *complete the additional interaction questionnaire on private protected areas in particular, thank you.*

Management

Do you have a single management plan for your park?
□ yes □ no □ DK

If yes*: Who developed it and when?*

____ □ DK

Can you make it available to me? □ yes □ no □ DK

How often do you update your management plan? __________________________ □ DK

Do you perform ecological monitoring on a regular basis?
□ yes □ no □ DK

If yes: □ vegetation □ animals □ other: ___________________________________

Which is your main source of information for management on each of the following topics?

Vegetation: ____ □ *DK*

Animals: ____ □ DK

Tourism: ____ □ DK

Finances: ____ □ DK

Maintenance: ____ □ DK

Other: ____ □ DK

Where did your manager(s) and/or PR gain their education and expertise from?

	local	**regional**	**national**	**international**	**DK**
1________________	□	□	□	□	□
2________________	□	□	□	□	□
3________________	□	□	□	□	□
4________________	□	□	□	□	□

Please specify if possible (study, training):

____

____

____

How often have the manager/PR positions been newly filled in the last 5 years? _______________

____

____

Do you use prescribed fire in the park?
□ yes □ no □ DK

If yes: purpose: ____

since when: ____

how often: ____

who performs: ____

Have you ever encountered problems with wildlife diseases?
□ yes □ no □ DK

If yes: *When and what:* ____

Which action did you take? ____

Did you collaborate with other entities regarding wildlife diseases?
□ yes □ no □ DK

If yes:
□ other private area □ public park □ community □ neighbours
□ governmental institution □ NGO □ tourism partners
□ other: ________________________________

Collaboration for:
□ veterinary support □ safety reasons □ collaboration
□ information / management options □ other: _______________________________

Did the disease(s) affect mammal trade? □ yes □ no □ DK

Did the disease(s) affect tourism? □ yes □ no □ DK

Did the disease(s) cause problems with neighbours? □ yes □ no □ DK

If yes*, please specify:* ____

Have you ever encountered problems with human diseases?
□ yes □ no □ DK

If yes: *When and what:* ____

Which action did you take? ____

Did you collaborate with other parties regarding human diseases?
□ yes □ no □ DK

If yes:
□ other private area □ public park □ community □ neighbours
□ governmental institution □ NGO □ tourism partners
□ other: ________________________________

Collaboration for: □ medical support □ safety reasons
□ information / management options □ collaboration □ other _________________

Did the disease(s) affect tourism? □ yes □ no □ DK

Did the disease(s) cause problems with neighbours? □ yes □ no □ DK

If yes, please specify: ____

Which disease(s) are you concerned about in general? Why?

____

____

Future development:

Which are the 3 most important positive influences / conditions on your park?

(1) ____

(2) ____

(3) ____

Which are the 3 most disturbing influences / threats on your park?

(1) ____

(2) ____

(3) ____

Do you expect any of the above impacts to change in the near future, i.e. next 10 years?
□ yes □ no □ DK

If yes, please specify: ____

____

Which reason is in your opinion the main risk of general failure in a nature reserve? Please rank on a scale from 1 (not relevant) to 5 (very important):

	1	**2**	**3**	**4**	**5**	**DK**
Ecological problems	□	□	□	□	□	□
Social issues	□	□	□	□	□	□
Economic mismanagement	□	□	□	□	□	□

Which habitat/species/special feature would you choose as ambassador to attract people and to raise awareness of conservation?

____

____

How do you perceive your park regarding the following purposes? Please rank on a scale from 1 (not relevant) to 5 (very important):

	1	**2**	**3**	**4**	**5**	**DK**
Business	□	□	□	□	□	□
Tourist attraction	□	□	□	□	□	□
Part of conservation system	□	□	□	□	□	□

Provider of ecosystem services	□	□	□	□	□	□
Educational institution	□	□	□	□	□	□
Mainly private property	□	□	□	□	□	□
Family home	□	□	□	□	□	□
Heritage site	□	□	□	□	□	□
Other: ______________________________	□	□	□	□	□	□

Would you be interested in a (governmental, communal or private) payment scheme for your provision of ecosystem services?

□ no: why? ____

____

□ yes: why and which services? ____

____

____

□ DK

Do you have any additional comments or questions relating to this interview? Please feel free to state them here or contact me any time (contact details see cover page).
Thank you for this interview!

____

____

____

____

Appendix 2: Interaction Questionnaire

Private Protected Area Networks in the Cape, South Africa

Interaction Questionnaire

This questionnaire is part of the research for a PhD in Conservation Biology. The project focuses on understanding the influence of geographical location on private protected areas and the functioning of their network in the Cape, South Africa. Results from this interview will be used to analyse social and ecological characteristics of your park and your interactions with other entities. Desired outcomes of the project are an inventory and maps of private conservation action as well as policy recommendations for conservation planning regarding biodiversity and ecosystem services provision.

My study strongly relies on your support and active participation. Your fully completed interview is of essential value to a comprehensive analysis and successful proceeding. Any information provided in this interview will be kept confidential. In return I will provide you with results which aim to be of value to the management and marketing of your reserve.

Completion of the questionnaire:

You are kindly asked to complete this questionnaire during a personal discussion with me. Please provide answers to every question. If a question does not apply to your individual situation 'NA' should be ticked; if you don't know an answer at the time of being asked 'DK' should be ticked. Additional data, information or suggestions are welcome any time and should be submitted to me using the contact details above.

Thank you for your active participation and contribution!

Location code: ____

Name code and position: ________________________________

Interviewer: ____

Date & duration of interview: ______________________________

With which of the following private protected areas of my preliminary sample do you have a direct or indirect interaction and since when do you interact (previous to your current job)?

	Never	Occasional	Frequent	Previous	Current
African Game Lodge	□	□	□	□	□
Aquila Game Reserve	□	□	□	□	□

Botlierskop Game Reserve	□	□	□	□	□
Buffalo Hills Lodges	□	□	□	□	□
Buffelsdrift Game Lodge	□	□	□	□	□
Buffelsfontein Private Game Reserve	□	□	□	□	□
Chandelier Game Lodge	□	□	□	□	□
Elandsfontein Private Game Reserve	□	□	□	□	□
Fairy Glen Private Game Reserve	□	□	□	□	□
Garden Route Game Lodge	□	□	□	□	□
Gondwana Game Reserve	□	□	□	□	□
Inverdoorn Game Reserve	□	□	□	□	□
Knysna Elephant Park	□	□	□	□	□
Ko-Ka Tsara Bush Camp	□	□	□	□	□
Lemoenfontein Game Reserve	□	□	□	□	□
Nyaru Game Reserve	□	□	□	□	□
Plettenberg Bay Game Reserve	□	□	□	□	□
Sanbona Wildlife Reserve	□	□	□	□	□
Steenbokkie Nature Reserve	□	□	□	□	□
Thali Thali Game Lodge	□	□	□	□	□

Are these interactions direct or indirect? Are they socioeconomic (related to company, tourism, education etc.) and/or ecological (related to wildlife, research etc.)?

	Direct / Indirect		**Socioeconomic / Ecological**	
African Game Lodge	□	□	□	□
Aquila Game Reserve	□	□	□	□
Botlierskop Game Reserve	□	□	□	□
Buffalo Hills Lodges	□	□	□	□
Buffelsdrift Game Lodge	□	□	□	□
Buffelsfontein Private Game Reserve	□	□	□	□
Chandelier Game Lodge	□	□	□	□
Elandsfontein Private Game Reserve	□	□	□	□
Fairy Glen Private Game Reserve	□	□	□	□
Garden Route Game Lodge	□	□	□	□
Gondwana Game Reserve	□	□	□	□
Inverdoorn Game Reserve	□	□	□	□
Knysna Elephant Park	□	□	□	□
Ko-Ka Tsara Bush Camp	□	□	□	□
Lemoenfontein Game Reserve	□	□	□	□
Nyaru Game Reserve	□	□	□	□
Plettenberg Bay Game Reserve	□	□	□	□
Sanbona Wildlife Reserve	□	□	□	□
Steenbokkie Nature Reserve	□	□	□	□
Thali Thali Game Lodge	□	□	□	□

How would you describe the ***indirect interactions*** *that you, regarding your job, have with the above listed reserves?*

□ Research forums/ conferences □ Tourism related meetings/ events

□ Legislation related events
□ Marketing related meetings
□ Maintenance related meetings
□ Education related events
□ Wildlife trade related events
□ Hunting related events
□ Beneficial events
□ Other: ______________________

*Which topics of **direct socioeconomic interaction** occur between you and these reserves?*

	Employ-ment	Manage-ment	Edu-cation	Marketing	Mainte-nance	Tourism	Other:
African Game Lodge	□	□	□	□	□	□	_____________
Aquila Game Reserve	□	□	□	□	□	□	_____________
Botlierskop Game Reserve	□	□	□	□	□	□	_____________
Buffalo Hills Lodges	□	□	□	□	□	□	_____________
Buffelsdrift Game Lodge	□	□	□	□	□	□	_____________
Buffelsfontein Private Game Reserve	□	□	□	□	□	□	_____________
Chandelier Game Lodge	□	□	□	□	□	□	_____________
Elandsfontein Private Game Reserve	□	□	□	□	□	□	_____________
Fairy Glen Private Game Reserve	□	□	□	□	□	□	_____________
Garden Route Game Lodge	□	□	□	□	□	□	_____________
Gondwana Game Reserve	□	□	□	□	□	□	_____________
Inverdoorn Game Reserve	□	□	□	□	□	□	_____________
Knysna Elephant Park	□	□	□	□	□	□	_____________
Ko-Ka Tsara Bush Camp	□	□	□	□	□	□	_____________
Lemoenfontein Game Reserve	□	□	□	□	□	□	_____________

Nyaru Game Reserve	☐	☐	☐	☐	☐	☐	____________
Plettenberg Bay Game Reserve	☐	☐	☐	☐	☐	☐	____________
Sanbona Wildlife Reserve	☐	☐	☐	☐	☐	☐	____________
Steenbokkie Nature Reserve	☐	☐	☐	☐	☐	☐	____________
Thali Thali Game Lodge	☐	☐	☐	☐	☐	☐	____________

*Which topics of **direct wildlife interactions** occur between you and these reserves?*

	Trade	**Knowledge**	**Equipment**	**Rehabilitation**	**Research**	**Other:**
African Game Lodge	☐	☐	☐	☐	☐	________
Aquila Game Reserve	☐	☐	☐	☐	☐	________
Botlierskop Game Reserve	☐	☐	☐	☐	☐	________
Buffalo Hills Lodges	☐	☐	☐	☐	☐	________
Buffelsdrift Game Lodge	☐	☐	☐	☐	☐	________
Buffelsfontein Private Game Reserve	☐	☐	☐	☐	☐	________
Chandelier Game Lodge	☐	☐	☐	☐	☐	________
Elandsfontein Private Game Reserve	☐	☐	☐	☐	☐	________
Fairy Glen Private Game Reserve	☐	☐	☐	☐	☐	________
Garden Route Game Lodge	☐	☐	☐	☐	☐	________
Gondwana Game Reserve	☐	☐	☐	☐	☐	________
Inverdoorn Game Reserve	☐	☐	☐	☐	☐	________
Knysna Elephant Park	☐	☐	☐	☐	☐	________
Ko-Ka Tsara Bush Camp	☐	☐	☐	☐	☐	________
Lemoenfontein Game Reserve	☐	☐	☐	☐	☐	________
Nyaru Game Reserve	☐	☐	☐	☐	☐	________

Plettenberg Bay Game Reserve	☐	☐	☐	☐	☐	__________
Sanbona Wildlife Reserve	☐	☐	☐	☐	☐	__________
Steenbokkie Nature Reserve	☐	☐	☐	☐	☐	__________
Thali Thali Game Lodge	☐	☐	☐	☐	☐	__________

*How do you **communicate** with these protected areas? Please fill in a ranking on a scale from 1 (not relevant) to 5 (very important):*

	Phone	**Email**	**Post**	**Social Media**	**Visits**	**DK**
African Game Lodge	☐	☐	☐	☐	☐	☐
Aquila Game Reserve	☐	☐	☐	☐	☐	☐
Botlierskop Game Reserve	☐	☐	☐	☐	☐	☐
Buffalo Hills Lodges	☐	☐	☐	☐	☐	☐
Buffelsdrift Game Lodge	☐	☐	☐	☐	☐	☐
Buffelsfontein Private Game Reserve	☐	☐	☐	☐	☐	☐
Chandelier Game Lodge	☐	☐	☐	☐	☐	☐
Elandsfontein Private Game Reserve	☐	☐	☐	☐	☐	☐
Fairy Glen Private Game Reserve	☐	☐	☐	☐	☐	☐
Garden Route Game Lodge	☐	☐	☐	☐	☐	☐
Gondwana Game Reserve	☐	☐	☐	☐	☐	☐
Inverdoorn Game Reserve	☐	☐	☐	☐	☐	☐
Knysna Elephant Park	☐	☐	☐	☐	☐	☐
Ko-Ka Tsara Bush Camp	☐	☐	☐	☐	☐	☐
Lemoenfontein Game Reserve	☐	☐	☐	☐	☐	☐
Nyaru Game Reserve	☐	☐	☐	☐	☐	☐
Plettenberg Bay Game Reserve	☐	☐	☐	☐	☐	☐
Sanbona Wildlife Reserve	☐	☐	☐	☐	☐	☐
Steenbokkie Nature Reserve	☐	☐	☐	☐	☐	☐
Thali Thali Game Lodge	☐	☐	☐	☐	☐	☐

*Do you know/ interact with **other** private areas not on the list above? Please state them here. They may be located anywhere in South Africa:*

1____________________________________2______________________________________

3____________________________________4______________________________________

5____________________________________6______________________________________

7____________________________________8______________________________________

9____________________________________10_____________________________________

How do you interact with these other reserves and since when?

	Never	Occasional	Frequent	Previous	Current
1	◻	◻	◻	◻	◻
2	◻	◻	◻	◻	◻
3	◻	◻	◻	◻	◻
4	◻	◻	◻	◻	◻
5	◻	◻	◻	◻	◻
6	◻	◻	◻	◻	◻
7	◻	◻	◻	◻	◻
8	◻	◻	◻	◻	◻
9	◻	◻	◻	◻	◻
10	◻	◻	◻	◻	◻

Are these interactions socioeconomic (related to company, tourism, education etc.) and/ or ecological (related to wildlife, research etc.)?

	Direct	Indirect	Socioeconomic	Ecological
1	◻	◻	◻	◻
2	◻	◻	◻	◻
3	◻	◻	◻	◻
4	◻	◻	◻	◻
5	◻	◻	◻	◻
6	◻	◻	◻	◻
7	◻	◻	◻	◻
8	◻	◻	◻	◻
9	◻	◻	◻	◻
10	◻	◻	◻	◻

How do you communicate with these protected areas? Please fill in a ranking on a scale from 1 (not relevant) to 5 (very important):

	Phone	Email	Post	Social Media	Visits	DK
1	◻	◻	◻	◻	◻	◻
2	◻	◻	◻	◻	◻	◻
3	◻	◻	◻	◻	◻	◻
4	◻	◻	◻	◻	◻	◻
5	◻	◻	◻	◻	◻	◻
6	◻	◻	◻	◻	◻	◻
7	◻	◻	◻	◻	◻	◻
8	◻	◻	◻	◻	◻	◻
9	◻	◻	◻	◻	◻	◻
10	◻	◻	◻	◻	◻	◻

*How do the following **conditions generally affect interaction** with other private protected areas? Please rank on a scale from 1 (not relevant) to 5 (very important):*

	1	**2**	**3**	**4**	**5**	**DK**
Personal positive relation (e.g. friendship)	☐	☐	☐	☐	☐	☐
Personal negative relation (e.g. argument)	☐	☐	☐	☐	☐	☐
Close proximity: support	☐	☐	☐	☐	☐	☐
Close proximity: competition	☐	☐	☐	☐	☐	☐
Active wildlife trade	☐	☐	☐	☐	☐	☐
Similar ecological conditions	☐	☐	☐	☐	☐	☐
Different ecological conditions	☐	☐	☐	☐	☐	☐
Ecological connectivity	☐	☐	☐	☐	☐	☐
Problem animal species	☐	☐	☐	☐	☐	☐
Invasive plants: collaboration	☐	☐	☐	☐	☐	☐
Fire Management: collaboration	☐	☐	☐	☐	☐	☐
Diseases: collaboration	☐	☐	☐	☐	☐	☐
Diseases: negative impacts	☐	☐	☐	☐	☐	☐
Marketing: collaboration	☐	☐	☐	☐	☐	☐
Marketing competition	☐	☐	☐	☐	☐	☐
Tourism: collaboration	☐	☐	☐	☐	☐	☐
Tourism: competition	☐	☐	☐	☐	☐	☐
Education: collaboration	☐	☐	☐	☐	☐	☐
Research: collaboration	☐	☐	☐	☐	☐	☐
Hunting: collaboration	☐	☐	☐	☐	☐	☐
Hunting: competition	☐	☐	☐	☐	☐	☐
Other: ________________________	☐	☐	☐	☐	☐	☐

Do you have any additional comments or questions relating to this interview? Please feel free to state them here or contact me any time (contact details see cover page).

Thank you for this interview!

____

____

____

____

Appendix 3: Financial Questionnaire

Private Protected Area Networks in the Cape, South Africa

Financial Questionnaire

This questionnaire is part of the research for a PhD in Conservation Biology. The project focuses on understanding the influence of geographical location on private protected areas and the functioning of their network in the Cape, South Africa. Results from this interview will be used to analyse social and ecological characteristics of your park and your interactions with other entities. Desired outcomes of the project are an inventory and maps of private conservation action as well as policy recommendations for conservation planning regarding biodiversity and ecosystem services provision.

My study strongly relies on your support and active participation. Your fully completed interview is of essential value to a comprehensive analysis and successful proceeding. Any information provided in this interview will be kept confidential. In return I will provide you with results which aim to be of value to the management and marketing of your reserve.

Completion of the questionnaire:
You are kindly asked to complete this questionnaire during a personal discussion with me. Please provide answers to every question. If a question does not apply to your individual situation 'NA' should be ticked; if you don't know an answer at the time of being asked 'DK' should be ticked. Additional data, information or suggestions are welcome any time and should be submitted to me using the contact details above.

Thank you for your active participation and contribution!

Location code: ____

Name code and position: _____________________________________

Date & duration of interview: ___________________________________

Interviewer: ____

Establishment of park

How high was the total start-up investment for the park? ______________________
□ DK □ no answer

Which kind of costs did this include? Please tick and give shares of overall investment:

	Yes	No	Share of investment
Land purchase	□	□	________________ %
Bureaucratic payments	□	□	________________ %
Infrastructure	□	□	________________ %
Buildings	□	□	________________ %
Other facilities	□	□	________________ %

Increased staff employment	□	□	__________________ %
Landscaping	□	□	__________________ %
Fencing	□	□	__________________ %
Animal stocks	□	□	__________________ %
Ecological Assessment/scientific advice	□	□	__________________ %
Other: _________________________	□	□	__________________ %

Do you want to provide amounts? □ yes □ no □ DK

Land purchase ___________________

Bureaucratic payments ___________________

Infrastructure ___________________

Buildings ___________________

Other facilities ___________________

Increased staff employment ___________________

Landscaping ___________________

Fencing ___________________

Animal stocks ___________________

Ecological Assessment/scientific advice ___________________

Other: __________________ ___________________

<u>Income</u>

What is the current annual average income of the park?

______________________________________ □ DK □ no answer

Can you give figures for the previous years? □ DK □ no answer

____

Did the income increase, decrease or fluctuate? □ DK □ no answer

____

How do the following features contribute to the total income of the park? Please tick and give shares and/or amounts:

	Yes	No	Share	Amount
Tourism (viewing):				
□ mammals	□	□	____ %	______________
□ birds	□	□	_____ %	______________
□ other _____________________	□	□	_____ %	______________
Education	□	□	_____ %	______________
Trophy hunting	□	□	_____ %	______________
Biltong hunting	□	□	_____ %	______________
Fishing	□	□	_____ %	______________
Wildlife trade	□	□	_____ %	______________
Events (conferences, weddings…)	□	□	_____ %	______________
Accommodation	□	□	_____ %	______________
Restaurant	□	□	_____ %	______________
Shop	□	□	_____ %	______________
Rentals	□	□	_____ %	______________
Farming	□	□	_____ %	______________
Natural products: ___________________	□	□	_____ %	______________
Other profession: ___________________	□	□	_____ %	______________
Other: ____________________________	□	□	_____ %	______________

What are the rates/prices in your park for the following:

Guided tour/drive etc.: ____

Stay overnight: ____

Hunting license: ____

Fishing license: ____

Special events/rentals: ____

Photographs/videos: ____

Equipment rental: ____

Other: ____

Expenses

What are the current average annual expenses / running costs of the park?

____ □ DK □ no answer

How do the following features contribute to the total expenses of the park? Please tick and give shares and/or amounts:

	Yes	No	Share	Amount
Employment	□	□	_____ %	______________
Staff education/ training	□	□	_____ %	______________
Maintenance/ infrastructure	□	□	_____ %	______________
Equipment	□	□	_____ %	______________
Wildlife trade	□	□	_____ %	______________
Veterinary/ control costs	□	□	_____ %	______________
Land lease	□	□	_____ %	______________
Permits/ licences	□	□	_____ %	______________
Marketing	□	□	_____ %	______________
Other: _____________________	□	□	_____ %	______________

Are there other expenses? □ yes □ no □ DK □ no answer

If yes, please specify: ____

Are you able/willing to provide more detailed economic values about your stocked species? What is the value of each species in terms of buying resp. selling?

Please indicate on a separate list, thank you.

Bureaucratic payments

Do you pay taxes? □ yes □ no □ DK □ no answer

How much? ___________________________ □ DK □ no answer

Are there other bureaucratic payments?
□ yes □ no □ DK □ no answer

If yes, please specify: ____

Are you able / willing to provide further data sets about your economic condition to be analysed by us?
□ yes □ no □ DK

Do you have any comments or questions about this interview? Please feel free to state them here or contact me any time (details see above). Thank you for this interview!

____

____

____

____

Appendix 4: List of Study Participants

List of 75 PPAs which actively participated in the study by conducting personal interviews. 5 reserves (marked with N/A) were excluded from assessments because they did not fulfil all criteria for analyses.

Name of PPA	Type of PPA
Aardvark Nature Reserve	habitat reserve
African Game Lodge	game reserve
Amathunzi Nature Reserve	game reserve
Aquila Game Reserve	game reserve
Arc-en-Ciel	game reserve
Baaskloof Private Nature Reserve	habitat reserve
Badshoek Hunting Experience	game reserve
Bakkrans Nature Reserve	habitat reserve
Bartholomeus Klip (Elandsberg Nature Reserve)	game reserve
Bontebok Ridge Reserve	game reserve
Bosch Luys Kloof Private Nature Reserve	game reserve
Botlierskop Game Reserve	game reserve
Buffalo Valley	habitat reserve
Buffelsdrift Game Lodge	game reserve
Buffelsfontein Game & Nature Reserve	game reserve
Buttonquail Private Nature Reserve	habitat reserve
Cape Flats Nature Reserve	habitat reserve
Cederberg Oasis	habitat reserve
Chandelier Game Lodge	game reserve
De Rust Private Nature Reserve	habitat reserve
Die Poort Private Nature Reserve	habitat reserve
Donkieskraal Guest Lodge & Private Game Reserve	game reserve
Drie Kuilen Nature Reserve	game reserve
Eastford Country Estate	habitat reserve
Elandsberg Eco Tourism	habitat reserve
Elandsfontein Private Game Reserve	game reserve
Farm 215	habitat reserve
Featherbed Nature Reserve	habitat reserve
Fisantekraal	N/A
Garden Route Game Lodge	game reserve
Gecko Creek Wilderness Lodge	habitat reserve
Goedvertrou	N/A
Gondwana Game Reserve	game reserve
Graham Beck Wines	game reserve
Groot Paternoster	N/A
Grootbos Lodge	habitat reserve
Grotto Bay Estate Home	habitat reserve

Jakkalsfontein Private Nature Reserve	habitat reserve
Jongensgat Private Nature Reserve	habitat reserve
Kagga Kamma Private Game Reserve	game reserve
Klein Cederberg	habitat reserve
Knysna Elephant Park	game reserve
Koeberg Nature Reserve	habitat reserve
Ko-Ka Tsara Bushcamp	game reserve
Koopmanskloof Private Nature Reserve	habitat reserve
Langverwacht	N/A
Lasarus Hunting Experience	game reserve
Lemoenfontein Game Reserve	game reserve
Matroosberg Private Nature Reserve	habitat reserve
Mooiberg Nature Reserve	habitat reserve
Mooiplaas Private Nature Reserve	habitat reserve
Pat Busch Mountain Reserve	habitat reserve
Plettenberg Bay Game Reserve	game reserve
Porcupine Hills	habitat reserve
Protea Farm Montagu	habitat reserve
Renosterkop	N/A
Rietfontein Guest Farm	game reserve
Rietfontein Game Reserve	game reserve
Rietfontein Private Nature Reserve	game reserve
Rietpoort Game Reserve	game reserve
Rolbaken Country Guest Farm	habitat reserve
Rondeberg Private Nature Reserve	habitat reserve
Rooiberg Lodge	game reserve
Sanbona Wildlife Reserve	game reserve
Simonskloof Mountain Retreat	habitat reserve
Steenbokkie Nature Reserve	game reserve
Swartriet Private Nature Reserve	habitat reserve
Teri-Moja Game Lodge	game reserve
Thali Thali Game Lodge	game reserve
Touwsberg Private Game & Nature Reserve	game reserve
Villiera Wildlife Sanctuary	game reserve
Vogelgat Nature Reserve	habitat reserve
Welbedacht Accommodation & Nature Reserve	habitat reserve
Witteberg Private Nature Reserve	habitat reserve
Wolfkop Nature Reserve	habitat reserve

Appendix 5: Vegetation coverage of study participants

Biome	Habitat Name	Size [ha]
Albany Thicket	Southern Cape Valley Thicket	624
Albany Thicket	Gamka Thicket	4910
Azonal Vegetation	Cape Lowland Alluvial Vegetation	70
Azonal Vegetation	Muscadel Riviere	555
Azonal Vegetation	Cape Seashore Vegetation	8
Azonal Vegetation	Muscadel Riviere	24
Azonal Vegetation	Cape Lowland Freshwater Wetlands	48
Azonal Vegetation	Tanqua Wash Riviere	0
Azonal Vegetation	Southern Karoo Riviere	4658
Forests	Southern Coastal Forest	64
Forests	Southern Afrotemperate Forest	612
Fynbos	Agulhas Limestone Fynbos	910
Fynbos	Albertinia Sand Fynbos	153
Fynbos	Atlantis Sand Fynbos	1700
Fynbos	Blombos Strandveld	18
Fynbos	Boland Granite Fynbos	15
Fynbos	Breede Alluvium Renosterveld	27
Fynbos	Breede Quartzite Fynbos	314
Fynbos	Breede Sand Fynbos	202
Fynbos	Breede Shale Fynbos	162
Fynbos	Breede Shale Renosterveld	1210
Fynbos	Cape Flats Dune Strandveld	2241
Fynbos	Cape Flats Sand Fynbos	13
Fynbos	Cederberg Sandstone Fynbos	84
Fynbos	Central Coastal Shale Band Vegetation	109
Fynbos	Central Inland Shale Band Vegetation	953
Fynbos	Ceres Shale Renosterveld	167
Fynbos	Eastern Coastal Shale Band Vegetation	9
Fynbos	Elgin Shale Fynbos	343
Fynbos	Elim Ferricrete Fynbos	17
Fynbos	Garden Route Granite Fynbos	1195
Fynbos	Garden Route Shale Fynbos	351
Fynbos	Graafwater Sandstone Fynbos	1575
Fynbos	Groot Brak Dune Strandveld	1455
Fynbos	Hawequas Sandstone Fynbos	311
Fynbos	Hopefield Sand Fynbos	4697
Fynbos	Knysna Sand Fynbos	118
Fynbos	Kogelberg Sandstone Fynbos	1281
Fynbos	Langebaan Dune Strandveld	601
Fynbos	Leipoldtville Sand Fynbos	942
Fynbos	Matjiesfontein Quartzite Fynbos	3032
Fynbos	Matjiesfontein Shale Fynbos	580

Fynbos	Matjiesfontein Shale Renosterveld	8845
Fynbos	Montagu Shale Fynbos	2207
Fynbos	Montagu Shale Renosterveld	21042
Fynbos	Mossel Bay Shale Renosterveld	9201
Fynbos	North Hex Sandstone Fynbos	1357
Fynbos	North Langeberg Sandstone Fynbos	6426
Fynbos	North Rooiberg Sandstone Fynbos	5022
Fynbos	North Swartberg Sandstone Fynbos	1419
Fynbos	Northern Inland Shale Band Vegetation	334
Fynbos	Olifants Sandstone Fynbos	424
Fynbos	Overberg Dune Strandveld	859
Fynbos	Overberg Sandstone Fynbos	2034
Fynbos	Peninsula Sandstone Fynbos	301
Fynbos	Saldanha Flats Strandveld	4564
Fynbos	Saldanha Granite Strandveld	25
Fynbos	South Hex Sandstone Fynbos	65
Fynbos	South Kammanassie Sandstone Fynbos	454
Fynbos	South Langeberg Sandstone Fynbos	1252
Fynbos	South Outeniqua Sandstone Fynbos	2123
Fynbos	South Rooiberg Sandstone Fynbos	11503
Fynbos	South Sonderend Sandstone Fynbos	62
Fynbos	South Swartberg Sandstone Fynbos	4833
Fynbos	Southern Cape Dune Fynbos	324
Fynbos	Swartland Alluvium Fynbos	3061
Fynbos	Swartland Granite Renosterveld	479
Fynbos	Swartland Shale Renosterveld	2374
Fynbos	Swartland Silcrete Renosterveld	10
Fynbos	Swartruggens Quartzite Fynbos	16539
Fynbos	Swellendam Silcrete Fynbos	3478
Fynbos	Tsitsikamma Sandstone Fynbos	5
Fynbos	Uniondale Shale Renosterveld	56
Fynbos	Western Altimontane Sandstone Fynbos	155
Fynbos	Western Coastal Shale Band Vegetation	141
Fynbos	Western Ruens Shale Renosterveld	152
Grassland	Karoo Escarpment Grassland	48
Nama-Karoo	Eastern Upper Karoo	594
Nama-Karoo	Gamka Karoo	33261
Nama-Karoo	Upper Karoo Hardeveld	8203
Succulent Karoo	Agter-Sederberg Shrubland	275
Succulent Karoo	Eastern Little Karoo	3296
Succulent Karoo	Koedoesberge-Moordenaars Karoo	2769
Succulent Karoo	Little Karoo Quartz Vygieveld	3285
Succulent Karoo	Prince Albert Succulent Karoo	4043
Succulent Karoo	Robertson Karoo	3882
Succulent Karoo	Swartruggens Quartzite Karoo	5033

Succulent Karoo	Tanqua Karoo	722
Succulent Karoo	Western Gwarrieveld	52
Succulent Karoo	Western Little Karoo	40422